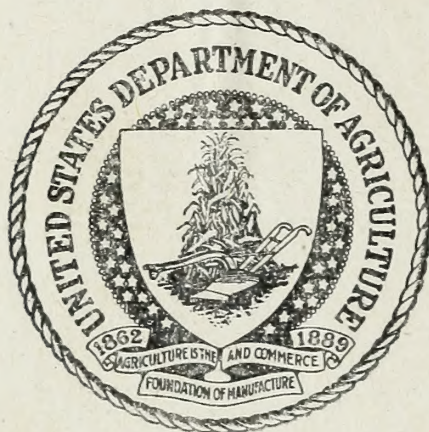


Historic, archived document

Do not assume content reflects current scientific knowledge, policies, or practices.

UNITED STATES
DEPARTMENT OF AGRICULTURE
LIBRARY



BOOK NUMBER

1

347634

Ag84

1929/30

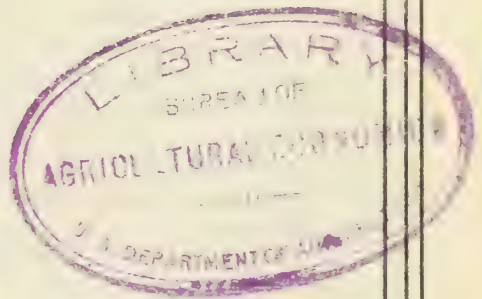
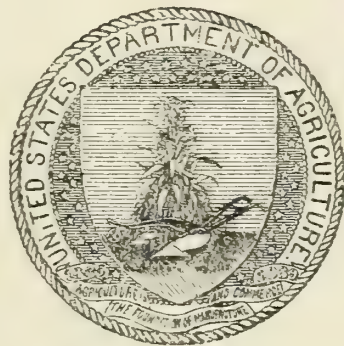
REPORT *of* THE
SECRETARY OF
AGRICULTURE
1930

341634

REPORT *of* THE SECRETARY OF AGRICULTURE

1930

1
Ag 24



UNITED STATES
GOVERNMENT PRINTING OFFICE
WASHINGTON : 1930

CONTENTS

The 1930 drought.....	Page 1
Effects of the drought.....	2
Drought relief.....	3
Emergency loans to farmers.....	5
Crop production in 1930.....	6
The wheat situation.....	11
The cotton situation.....	11
The livestock situation.....	13
The dairy situation.....	15
The poultry situation.....	16
The fruit and vegetable situation.....	17
Farm income in 1929 and 1930.....	18
Factors in the current depression.....	20
Agricultural exports and imports.....	22
Overproduction and crop adjustments.....	25
Farm taxation.....	30
Farm-land values.....	32
Farm-credit conditions.....	33
Land utilization.....	37
Field research in farm management.....	41
Movements of population.....	42
The tariff act of 1930.....	43
Foreign agricultural service.....	45
Regulating trade in perishable products.....	46
Census of agriculture.....	47
Cooperation with the Federal Farm Board.....	49
Extension work.....	49
Informational work.....	52
Trading in futures.....	54
Plant quarantines.....	55
Control of insect pests.....	57
Research in chemistry and soils.....	60
Plant industry achievements.....	65
Progress in animal industry.....	71
Dairy research and service.....	73
Wild-life conservation and control.....	75
Food and drug administration.....	77
Experiment stations.....	79
Home economics.....	81
Progress in weather forecasting.....	82
The national forests.....	83
Federal-aid roads.....	88
Financial statement.....	93

REPORT OF THE SECRETARY OF AGRICULTURE

WASHINGTON, D. C., *November 15, 1930.*

To the PRESIDENT:

THE 1930 DROUGHT

The worst drought ever recorded in this country prevailed during much of the 1930 crop-growing season and greatly reduced farm production. Widespread droughts occurred in 1881, 1894, 1901, 1911, 1916, and 1924. These, however, did not equal the drought of the present year in duration, in the extent of the areas covered, in deficiency of precipitation, or in severity. In 1881 June was very dry in the Southwest, and July and August in the central valleys and in the East. Droughty conditions in 1894, though severe, were confined to the central valleys and the Northwest. In 1901 the central valleys, especially the western Corn Belt, suffered most. In 1911, the greatest shortage in precipitation occurred rather early in the season. The droughts of 1916 and 1924 covered comparatively small areas.

Up to the 1st of September, 1930, an area in the Middle Atlantic States, comprising mainly Maryland, Virginia, and West Virginia, had deficient precipitation every month from December, 1929. Over much of the interior of the country, especially in the Ohio and middle Mississippi Valleys, the drought persisted for six months, from the 1st of March to the 1st of September. For the spring season, March to May, the driest States were those in the Potomac, Ohio, and middle Mississippi Valleys. In June the drought area extended to the South Central States, especially those in the lower Mississippi Valley. In July the drought was severe in most States east of the Rocky Mountains. August was deficient in precipitation in most sections until about the middle of the month. Thereafter scattered rains partly relieved conditions over an area comprising principally South Dakota, Nebraska, and much of Kansas. Toward the end of August, however, the drought was intensified in some Northern and Southeastern States that had not previously been severely affected.

Precipitation in the spring (March to May) was the lowest of record in West Virginia, Kentucky, Indiana, Illinois, and Missouri. Only Florida and Nebraska had a rainfall equal to the normal rainfall for the entire area east of the Rocky Mountains. The summer (June to August) rainfall was the lowest ever recorded in Maryland, Virginia, West Virginia, Kentucky, Tennessee, Arkansas, and Mississippi. In 15 States east of the Rocky Mountains, the average was little more than half the normal. In general, July was the driest and hottest month of the season. Rainfall in July was deficient in all States east of the Rocky Mountains, except New England and

Georgia. The deficiency exceeded all previous records in Maryland, Virginia, West Virginia, Ohio, Kentucky, Illinois, Missouri, and Arkansas, and averaged only about one-third of the normal. Some other important agricultural States had the driest July in more than 30 years. On the other hand most of the Rocky Mountain area had an unusually abundant rainfall. In Colorado all previous high rainfall records were broken for the months of July and August combined. In Wyoming the August rainfall exceeded the previous maximum for that State by more than 50 per cent.

River stages showed the severity of the drought. Low river stages are not unusual for July and August in the Missouri Basin above Pierre, S. Dak., and that part of the upper Mississippi Basin above the Iowa-Minnesota line. In the remainder of the drainage area of the Mississippi River system, however, and on the Atlantic slope of Pennsylvania, Maryland, Virginia, and North Carolina, the dry weather was plainly reflected in low-water stages. Many of the small streams in the Missouri Basin became dry. In the rest of the drought area all streams were either as low as they had ever been in August, or were very close to the low record.

Wells failed; water for stock was scarce; and in some places sewage disposal became an acute problem. Hydroelectric plants on large streams did not suffer, but some plants on the smaller streams had to shut down. Navigation on rivers controlled by locks, dams, and so forth was not interrupted, but on the Mississippi, especially north of Cairo, low water made it necessary materially to decrease the length of tows. This was a serious interruption to navigation.

What caused the drought is a question that can not as yet be answered. All that can be said is that there was a prolonged stagnation of the air over nearly the whole continental extent of the United States. In ordinary years this great blanket of atmosphere overlying the continent is in more or less active circulation. Cool air from the polar regions moves southward from time to time. This circulation was especially absent this summer. Warm air from the tropical latitudes moves northward at intervals. Air from the oceans and from the Gulf of Mexico moves inland. There is a more or less active and continuous interchange of these different air masses which causes the favorable conditions that usually prevail. This interchange did not occur for a long time during the present great drought. Occasional showers and thunderstorms here and there seemed only to dry out the overlying air masses. Only a part, at best, of the water thus precipitated is evaporated back into the free air. With little or no new moisture borne in by winds from the oceans, each successive inland shower, coupled with the stagnation and absence of general rain-causing processes, tended further to deplete the moisture supply and intensify the drought. The lack of precipitation permitted the culmination of excessive temperatures, which are normally at their maximum over most of the United States about the last week of July.

EFFECTS OF THE DROUGHT

Only in North Dakota, Montana, Oklahoma, Texas, and New Mexico, did the drought come early enough to reduce seriously the yields of wheat, oats, or barley. These crops, taking the country as

a whole, yielded somewhat more than the usual average. Irrigated crops, such as sugar beets and some fruits largely grown outside the drought area, also produced well. Practically all nonirrigated crops growing late in the season, however, were affected, particularly the feed crops. Hay and pasturage suffered greatly. About 30 States, including all those in the great central area extending from Virginia to Montana and from Pennsylvania to Texas, were hard hit. In many localities farmers have little to sell and will be obliged to practice strict economy in their livestock feeding. In some parts of the country, thousands of farm families will suffer privation. Unhappily, moreover, the cut in farm production coincided with a sharp decline in the demand for farm commodities, and consequently in the farm-commodity price level. This development, a result of world-wide economic depression, bore heavily upon farmers outside the drought areas as well as upon those within it. Only in the case of a few commodities was the drop in production partly compensated by a rise in prices. Farm-commodity prices as a group slumped toward the end of the season to the lowest point in 15 years. Hence, the immediate economic consequences of the drought fell predominantly on the farmers. They were not shared to any great extent by the consuming public. Perhaps the farm-commodity price level would have gone lower under the shock of the world depression had farm production in this country been normal. In the case of some crops sold on the world market, prices are not greatly affected by variations in the production of the United States. Commodities produced and sold on a domestic basis usually respond quickly to changes in domestic supply conditions. One thing is clear. The demand for farm commodities fell off more than the supply did. Hence, the drought though it may have retarded the decline of prices, did not, except in the case of a very few commodities, cause any advance. Eventually the shortage of feed for livestock may reduce the supply of meat products and bring about a rise in the prices of those commodities, but no such results are noticeable as yet. Some areas not affected, or little affected, by the drought are finding wider markets for their products than they would otherwise have had. Local benefits of that sort, however, can not be set down on the credit side of the agricultural ledger, because they are merely the reverse side of distress and difficulty elsewhere. Through an unusual combination of economic circumstances, the effects of the drought were heavily concentrated upon agriculture instead of being rather widely diffused, as usually happens when serious crop shortages occur.

DROUGHT RELIEF

On August 14, at a conference of governors of drought-stricken States called by you, it was agreed that a committee representing the various Federal agencies concerned should be organized, that State drought committees should be set up, composed of State officials and farmer, banker, and Red Cross representatives, and that county committees should be organized in each county seriously affected by the drought. These county committees were to survey their local situations and determine the extent and character of the needs. At your request I have served as chairman of the Fed-

eral Drought Relief Committee, and much of the work of the committee has been done by members of the staff of the Department of Agriculture, to which representatives of several other departments have contributed materially. The State and county committees were set up promptly in most of the States and in general have been active where definite need has existed. Surveys of needs are still in progress.

The State committees were urged to give consideration particularly to credit needs of farmers for funds to finance necessities for their families, for feed for livestock, and for financing crop production. At a meeting of banker representatives of the State committees on August 27, recommendation was made for the setting up of agricultural-credit associations where normal financial agencies are not in position to furnish credit to those who can offer tangible security as a basis for loans. Some of the States decided that they had no need for such associations, while others have taken or are taking active steps looking toward their organization.

The railroads have cooperated by granting reduced rates on the movement of hay, feed, and water into drought-stricken counties, and livestock out of such counties into sections where feed is available. These rates were put into effect during the latter half of August to continue until October 31. They were later extended to November 30.

The Department of Agriculture assumed the responsibility for (1) determining the counties in which drought damage had been sufficiently severe to justify the granting of these rate reductions to farmer-consumers, and (2) issuing certificates recommending the granting of the rate reductions on specific shipments to farmer-consumers, or dealers. Several hundred counties were certified as in need of this aid, on the basis of telegraphic advice from county extension agents regarding needs and on crop conditions shown in the August crop report. About August 15 a special questionnaire on the condition of pasture, feed crops, and corn was sent to 108,000 crop correspondents in the drought-stricken States. Additional counties were certified to receive the reduced rates on the basis of the information contained in these questionnaires. In general, certification was made only of those counties that showed a condition of pastures, corn, and feed crops of not more than 50 per cent of normal. Altogether, 1,017 counties in 21 States were certified to the railroads to receive the rate reductions. The list included all or a large part of the counties in the States of Maryland, Virginia, West Virginia, Kentucky, Tennessee, Mississippi, Missouri, Arkansas, Louisiana, and Oklahoma, with considerable numbers in Ohio, Illinois, Indiana, Alabama, Texas, and Montana, and a few in Pennsylvania, North Carolina, Georgia, New Mexico, and Wyoming.

The rate reductions were made available on direct shipments to individual farmers or groups of farmers whose feed supply and pastures had been seriously depleted by the drought and who were in need of assistance, and also to dealers who agreed to sell to such farmers and to pass on to them the advantage of the reduced rates. Certificates covering the movement of many thousand cars of hay and feed have been issued, and material relief has been given the farmers over a wide area.

To aid in providing employment in the drought-stricken States, the Federal-aid road authorizations for the fiscal year 1932 were made available for the making of contracts for construction, and, under certain limitations, arrangements were made for payments on such contracts. As yet, however, comparatively little has been done in the utilization of these funds.

The cooperation of wood-using industries, particularly the railroads and the cooperage industry, was requested in making purchases of ties, timber, and stave bolts from farmers owning wood lots in the drought area. Extension agents assisted in the location of available supplies of feed, and a special letter on feed and livestock market conditions was sent weekly to these agents by the Bureau of Agricultural Economics. That bureau also gathered and distributed information on the location of feed and hay surpluses. The planting of fall pasture crops and gardens was urged, and in certain States loans were made to farmers to assist them in planting such crops. In other States seriously affected by drought, in which the seed loan appropriation was not available, the American Red Cross cooperated by giving seed rye for pasture to farmers who were unable to obtain it, and also by distributing seed for fall gardens.

Extension agents have called the attention of farmers to the need for saving available surpluses of seed for farm crops, particularly corn, and have suggested to farmers outside the area seriously affected by drought the desirability of saving extra supplies of seed corn, with a view to having supplies available for the drought area next spring. Home-demonstration agents not only urged the planting of fall gardens and the preservation for winter use of all available surpluses of vegetable crops, but demonstrated the canning of beef and poultry, thus aiding in saving for food many animals which otherwise would have been sacrificed for lack of feed and water. These agents have also cooperated with public-health agencies and the Red Cross in assisting rural women to make the best possible use of available food supplies or of funds for their purchase, particularly with a view to prevention or control of nutritional diseases such as pellagra.

EMERGENCY LOANS TO FARMERS

Following severe damage to crops by storms and floods in the Southeastern States, Congress early in 1929 made \$6,000,000 available to the department for emergency loans to farmers for seed, feed, and fertilizer. About \$5,550,000 was loaned in Virginia, North Carolina, South Carolina, Alabama, Georgia, and Florida on staple crops. About \$200,000 was loaned in southern Florida on vegetables. By June 30, 1930, \$4,580,683 had been repaid. This is an excellent record, especially in view of the stringent financial conditions that prevailed in the area and the low prices received by the growers there for the principal crops. This year Congress appropriated an additional \$6,000,000 for emergency loans to farmers in drought, storm, or flood stricken areas. The amount became available by the approval of the first deficiency act of March 26, 1930. From this fund loans were made to other farmers in the six States already mentioned, and crop financing was aided in Indiana, Illinois, Missouri, Oklahoma, New Mexico, Minnesota, North Dakota, and Montana. Except

in the Southeastern States and in North Dakota and Montana, however, the amounts loaned were negligible. The total amount loaned in the spring of 1930 was \$4,612,136. In August and September approximately \$500,000 was loaned in Florida on winter vegetables, while loans up to October 15 to aid farmers to plant fall pasture crops in Alabama, Missouri, Oklahoma, and Virginia had amounted to \$170,000.

CROP PRODUCTION IN 1930

As a result of the drought, crops were poorest this year from Virginia and Maryland westward to central Missouri, Arkansas, and Oklahoma. In much of this area, including most of Ohio, Kentucky, and West Virginia, the southern third of Indiana and Illinois, and south-central Pennsylvania, the yields were only about two-thirds of the normal. In a larger area the crops were somewhat less severely affected. This area included western Pennsylvania, Michigan, northern Indiana and Illinois, most of Iowa, the Dakotas and Montana, and the region from Kansas south to central Texas. On the other hand, crops were mostly average or better than the average in New England, New York, New Jersey, Nebraska, and Wisconsin. Fair yields were harvested in most of the Cotton Belt east of the Mississippi River. Particularly good yields were obtained in Georgia and South Carolina, and yields were above the average in Alabama. Satisfactory results were obtained also in most of the Western States, with the exception of Montana and parts of Washington and Wyoming. In Colorado, Arizona, and Oregon crop yields were 13 to 19 per cent heavier than usual. They were about 10 per cent better than usual in California.

Acreage

Spring weather favorable for farm work and an ample supply of labor brought an increase of about 1 per cent in the total acreage planted, though farm-commodity prices were rather unfavorable at planting time. Large increases in acreage were made in the case of several important cash crops. Thus the acreage in flaxseed was increased 47 per cent, that in rye 9 per cent, that in broomcorn 31 per cent, that in beans 12 per cent, that in rice 10 per cent, and that in tobacco 5 per cent.

The acreage in potatoes was increased 3 per cent, that of sweet-potatoes 4 per cent, and that of other commercial truck crops 6 per cent, though the strawberry acreage was reduced appreciably and the cabbage, carrot, onion, and spinach acreages in a lesser degree. The principal increases were in lettuce, snap beans, green peas, tomatoes, and muskmelons. Increased acreages also were planted to watermelons, cauliflower, and celery. The acreage of vegetables grown for canners and packers was one-sixth larger than in 1929 and was the largest on record. The acreages in certain crops were decreased. Some shifts from barley to oats took place, owing to the unusually early spring and to the fact that trouble had been experienced the previous year from barley diseases. In parts of the South a shift was made from cotton and peanuts to feed crops. In the Corn Belt States, which began the season with rather large sup-

plies of hay on hand, some shift took place from hay to grains and cash crops. As already noted, however, the increase in the total acreage and in the acreages of particular crops was more than offset by low yields. In proportion to the population, the harvest showed nearly the usual production of food crops, about an average production of cotton, tobacco, flaxseed, and broomcorn, and a greatly reduced production of feed for livestock.

Cereal and Other Food Crops

The wheat crop totaled about 840,000,000 bushels, as compared with 806,000,000 bushels in 1929 and an annual average of 833,000,000 bushels for the five years 1924-1928. Winter wheat, which constituted 597,000,000 bushels, was a larger proportion than usual of the total wheat output. Its relative amount reflected continued gradual expansion of wheat acreage in the Great Plains area, relatively low production of durum wheat on a reduced acreage, and a production slightly below the average production of the other spring wheats. Rye production, with yields close to the usual average, was estimated at 46,700,000 bushels, as compared with 40,500,000 bushels harvested in 1929 and an average production of 50,900,000 bushels during the five years 1924-1928. Among the grains principally used for human food only buckwheat is in seriously short supply. This crop was caught by drought in practically all States where it is grown and yielded only about 12 bushels an acre, or less than in any previous year since 1886. The total production is estimated at 8,700,000 bushels, or 24 per cent less than in 1929 and 37 per cent less than the annual average of the 5-year period 1924-1928.

Rice production is estimated at 38,600,000 bushels, as compared with 40,200,000 bushels harvested last year and an average of 39,100,000 bushels harvested annually during the preceding five years. The yield was slightly below the average and much below that of 1929. The bean crop was very large. Sugar-beet production likewise was unusually heavy. The production of sorgo for sirup, however, was considerably reduced. Peanut production was less than usual.

Cotton

Cotton production is estimated at 14,486,000 bales, as compared with 14,828,000 bales harvested in 1929. The crop, though not large in comparison with those of some recent years, is nevertheless more than ample for the market's reduced requirements. Yields varied greatly in different States. In the eastern Cotton Belt the severe winter of 1929-30 and dry weather during the early summer kept the boll weevil in check. As a result South Carolina, Georgia, and Florida are harvesting the best yields of cotton in a number of years. Record yields are being harvested in New Mexico and Arizona. California's yield, estimated at about 400 pounds an acre, is the highest since 1916. Oklahoma and Arkansas, on the other hand, have the lowest yields since 1923. Texas has the lowest yield since 1925. Taking the cotton-producing States as a whole, however, the yield per acre is expected to be close to the usual average, or about 155 pounds.

The Feed Crops

Total production of corn, oats, barley, and grain sorghums was estimated at only 90,000,000 tons, as compared with 103,000,000 tons in 1929 and an annual average of nearly 107,000,000 tons during the 5-year period 1924-1928. All told, the output of the principal feed grains is thus about 13 per cent less than in 1929 and 16 per cent less than the 5-year average.

Corn production is estimated at 2,047,000 bushels, or 22 per cent less than the production in 1929 and 24 per cent less than the average annual production of the preceding five years and less than the production in any year since 1901. The yields were low in practically all the important corn States. In the seven States most seriously affected by the drought yields averaged less than half those usually obtained. The proportion of the crop available in the form of grain will probably be considerably less than in any recent year, since much more than usual of the crop will be utilized for silage and forage.

Oat production was reduced by the drought in North Dakota and Montana and in parts of the South. In other States, however, the yield per acre was equal to or better than the average. For the country as a whole, oat production is estimated at 1,410,761,000 bushels, or 15 per cent above the production in 1929 and 3 per cent above the average production of the 5-year period 1924-1928. The barley crop is estimated at 328,000,000 bushels, about 8 per cent more than the quantity harvested in 1929 and 36 per cent more than the average production of the preceding five years. The yield per acre was estimated at 25.7 bushels, as compared with 23.2 bushels in 1929 and an average of 25 bushels during the previous 10 years.

Grain sorghum, which takes the place of corn in parts of the Southwest, was much affected by the drought in Texas, Oklahoma, Kansas, and New Mexico, where about nine-tenths of the crop is usually grown. Including the grain sorghums that will be fed to livestock in the bundle, the production was estimated at 79,232,000 bushels, as compared with 100,845,000 bushels in 1929 and an annual average of 128,175,000 bushels during the 5-year period 1924-1928. The output was lower than in any year since 1919, when the records on this crop were started.

Hay production was estimated at 96,100,000 tons, or about the same as in 1926 and less than the production in any other year since 1918. It was 16 per cent below the production in 1929 and 10 per cent below the average annual production of the previous five years. Both tame and wild hay were damaged by the drought. In some States grass and clover gave but a fraction of their usual yield. Alfalfa, soybeans, and other deep-rooted hay crops, though less hurt, did not make a normal growth. Wild hay made up 12,000,000 tons of the hay crop and tame hay 84,100,000 tons. The wild-hay crop was the smallest in 20 years, with the exception of that in 1926, and the tame-hay crop was the smallest since 1921. Yields were below the average in all States except in New England, Iowa, Wisconsin, Georgia, Colorado, the far Southwest, and the Pacific Coast States. In California, Oregon, and Arizona record hay crops were obtained.

The drought killed new seedlings of grass and clover in many fields and the result will be noticed in next year's hay crop.

Livestock feed supplies are augmented, of course, by such commercial feedstuffs as bran, middlings, cottonseed meal, and flaxseed meal. Output of these products is expected to be somewhat heavier than usual this year, though not in excess of the production last year. Taking the feed situation as a whole, the total tonnage of feed grain, commercial feedstuffs, and hay produced will be about 12 per cent below the usual average. In proportion to the number of livestock needing to be fed, it will be about 10 per cent less than usual. Economical use of the available supply will stretch it somewhat. More straw and corn fodder will be fed, as well as increased quantities of wheat and cottonseed. Hogs will be marketed at lighter weights. Fewer cattle will be put on grain feed, and these will be fed grain for shorter periods. The grain ration for livestock of all kinds will be reduced. These expedients will not, however, suffice to obviate serious effects from the feed shortage.

Tobacco and Flax

Tobacco production was estimated in October at 1,500,000,000 pounds, the total including about 800,000,000 pounds of flue-cured tobacco and 290,000,000 pounds of Burley tobacco. Yields in Kentucky and Virginia were extremely low and reduced the average yield for the United States to about 700 pounds an acre, or less than in any year since 1897. Though the area planted was about 100,000 acres greater, the production was about 1 per cent less than in 1929. However, the final yield is not yet accurately known, since it depends greatly on shrinkage in curing.

Flax production was estimated at 25,200,000 bushels, or 50 per cent above the production in 1929, but only approximately 6 per cent above the average annual production during the five years 1924-1928. As a result of the increased planting previously noted, the flax area was nearly 4,400,000 acres, by far the largest ever planted to flaxseed in the United States. The yield, however, averaged only 5.7 bushels an acre. This was only slightly better than the yield in 1929 and was the second lowest yield in 10 years.

Fruits and Vegetables

Fruit production was at least one-fifth greater than in 1929. Prunes, plums, and apricots were abundant, and a good crop of citrus fruits is expected. Apples and peaches were a smaller proportion of the total supply than in the previous year. Taken as a whole, the bearing acreage of fruits and nuts produced less than an average yield per tree or vine, but the reduced yield was offset by an increase in the bearing acreage, which continued the trend of recent years. The net result was a fruit crop somewhat greater than the usual average total supply. Allowing for the year's increase in population, it represented about the average quantity per capita.

For the second year in succession much of the central portion of the country had a light fruit crop. In the northeastern, southeastern,

and western areas conditions, however, were more favorable. The supply from these areas was more than sufficient to offset the shortage in the central areas. New England, New York, New Jersey, Florida, Washington, Oregon, and California had an exceptionally good year. The large crop in California was in sharp contrast to that of 1929, when early spring freezes limited the output.

Apple production was about 153,400,000 bushels, or 8 per cent larger than the short crop of 1929, though 15 per cent below the average crop of the 5-year period 1924-1928. The commercial crop, or the part marketed for consumption as fresh fruit, amounted to nearly 32,000,000 barrels, slightly below the average quantity but about 10 per cent larger than the commercial crop of 1929.

The peach crop was 49,250,000 bushels, 8 per cent larger than the 1929 production, but 13 per cent below the 5-year average. Low winter temperatures and spring frosts cut the crop sharply in the Central States. It was practically a failure in Indiana, Illinois, Missouri, and Arkansas.

The pear crop was close to 25,000,000 bushels, about one-sixth larger than either the 1929 production or the previous 5-year average production, and was the largest crop on record except that of 1926. It was relatively light in most of the central and southern areas, but exceptionally large in New York and the three Pacific Coast States, where the bulk of the crop is grown.

Grape production amounted to 2,350,000 tons, about an average production, but 12 per cent larger than in 1929. The increase was in California. Production outside California was less than in the year before, though 8 per cent better than the average. The orange and grapefruit crop now being picked is estimated at almost half larger than in the previous season and lemon production at about one-fourth larger.

Potato production, on a slightly increased acreage, amounted to about 352,200,000 bushels, as compared with 359,800,000 bushels in 1929 and an average crop of 393,000,000 bushels during the five years 1924-1928. The early commercial potato crop largely escaped the drought. It was grown on an acreage one-fifth larger than that of the previous year, and the output was correspondingly larger, the yields averaging about the same. A large part of the late-potato crop was damaged. The northeastern and central regions, including many of the important late-potato-shipping States, suffered the full effect of the hot, dry spell. The sweetpotato crop also was hurt. The total production is estimated at 67,670,000 bushels, as compared with 84,660,000 bushels in 1929. Fall rains partly restored the crop in southern areas. In the four commercially important sweetpotato-producing States on the Atlantic coast north of the Carolinas drought persisted into the fall. Production in this area was much below normal.

Despite the increase in the vegetable and truck-crop acreage, yields were so much lower than in 1929 that the supply of these perishables was not greater. Snap beans and sweet corn were the vegetable crops most seriously affected by the drought. The supply of sweet corn was comparatively short. The production of other canning crops was not exceptionally light in the aggregate, though the yields were low.

THE WHEAT SITUATION

Income from this year's wheat crop is likely to be considerably below that received from the previous crop. Farm prices through the first four months of the marketing season (July through October) averaged only about 71 cents a bushel, whereas in the corresponding months of the previous season the average was about 109 cents a bushel. Despite the short corn crop and the feeding of much wheat to livestock in the United States, prices have declined to the lowest level since 1901 and 1902.

The carry-over of wheat has increased each season since 1926. The carry-over in the United States on July 1, 1930, amounted to 275,000,000 bushels, as compared with 247,000,000 on July 1, 1929, and a 5-year average of 122,000,000 bushels. The world stock as of July 1, though very large, was not quite as large as at the beginning of the previous season. World stocks outside Russia and China probably were reduced approximately 100,000,000 bushels during the 1929-30 season.

The world is harvesting about an average wheat crop. Production outside Russia and China for the 1930-31 marketing season probably will exceed the production of the past season, when several countries had short crops. Conditions reported toward the end of October indicated that the world's wheat crop will amount to about 3,650,000,000 bushels—about 160,000,000 bushels more than in 1929, but 320,000,000 bushels less than in 1928. During the 1929-30 season consumption apparently exceeded production by at least 100,000,000 bushels. Short feed-grain crops and low wheat prices should cause some increase in wheat consumption, both in the United States and in Europe. Increased consumption in the United States alone may suffice to offset the increase in world production.

Russia continues to be an uncertain factor in the situation. Apparently the Russian wheat crop is better than that of the previous season. Russia's exports through southern ports are reported as having amounted by the middle of October to about 25,000,000 bushels. Just before the World War Russia was the leading wheat-exporting country. During the war and the revolution, however, her exports practically ceased. In the 1926-27 season Russia's exports amounted to 49,000,000 bushels and then declined to small amounts until the beginning of the present season. Apparently wheat production in Russia is now equal to or greater than her pre-war production. Although Russia's exports during the present season may not greatly exceed those of the 1926-27 season, the producers in the United States should watch carefully the possibility of keen competition from Russia during the next 10 years.

THE COTTON SITUATION

Developments in the cotton market continue to emphasize the importance of adjusting as far as possible the production of each quality of cotton to market requirements. Our cotton crop in 1929 was the fifth largest in our history, and the area harvested was exceeded only in 1925 and 1926. As the carry-over from the previous year was relatively small, the world supply of American cotton in the

1929-30 season was the smallest in five years. Farmers who marketed their crop early received fairly good prices. From August to December, 1929, the prices paid to farmers for cotton ranged from about 18 cents to 16 cents a pound, or slightly less than the average for the previous season. These are the months during which a large proportion of the crop normally leaves the farmer's hands. Thereafter prices declined, and at the close of the marketing season were about 11 cents a pound, or on a level as low as that reached during the large crop year 1926-27. The downward movement of prices partly reflected reduced world consumption of American cotton. In fact, there has been a shift away from American cotton to that grown elsewhere during the last two years. Price differences during this period have been less favorable to American cotton, and quality differences between American and foreign growths have been less marked. It is evident that an adjustment between the quality of cotton produced and the consumers' preferences is very important if American cotton producers are to maintain their supremacy in the world's cotton markets.

Yields of cotton per acre in 1929 averaged 155 pounds for the United States as a whole. This was about equal to the average for the 10-year period 1919-1928. There were wide variations in the yields of the different States. In Texas, Oklahoma, and North Carolina yields were unusually low. In all the other cotton-producing States yields were above the average. Although the crop as a whole was fairly satisfactory from the standpoint of yield, the quantity of each quality produced was not in adjustment with the market's wants. In fact, it was distinctly lacking in that respect, whereas some foreign cottons, notably Indian cotton, showed improvement. In recent years the Department of Agriculture has gathered and published information on the number of bales of cotton ginned of each grade and staple. The last grade and staple reports showed that the cotton ginned during 1929-30 was lower in grade and slightly shorter in staple than the cotton ginned during 1928-29. About 20 per cent of the 1929 crop was thirteen-sixteenths of an inch or less in length of staple; 38 per cent was seven-eighths of an inch; 19 per cent was fifteen-sixteenth of an inch; 12 per cent was $1\frac{1}{2}$ inches; 11 per cent was $1\frac{1}{16}$ inches or longer. No less than 24 per cent of all the cotton ginned in the United States during 1929-30 was untenderable on futures contracts. In 1928-29 the corresponding proportion was 18 per cent.

These facts have a close bearing upon the trend of the world's consumption of American cotton. Previous to 1929-30 there were three years of record world consumption of American cotton. The total consumed in 1926-27 was about 15,777,000 bales. In 1927-28 the total consumption was 15,407,000 bales, and in 1928-29, 15,066,000 bales. Never in any previous year had the world consumption reached 15,000,000 bales. In 1929-30 the world's consumption of American cotton was 2,000,000 bales less than in 1928-29. The world's consumption of all kinds of cotton in 1929-30 declined only about 700,000 bales from that of the previous year. American cotton was thus replaced to a considerable extent by that grown in other countries. The consumption of Indian cotton increased 900,000 bales and the consumption of cotton from other countries increased 500,000

bales. Reduced consumption in our own mills accounted for half the decline in the world's consumption of American cotton. The remaining drop of 1,000,000 bales was in Europe, half of it in Great Britain. Comparative prices and qualities made it economical for many spinners to use foreign cotton exclusively or for mixing with American cotton.

More information is needed about the trend in the world's consumption of various growths, and study of the problem is under way in the department. Its results should help farmers to anticipate changes in the demand and to adjust their output thereto more promptly than they have done heretofore. Efforts to improve the quality of cotton grown in the United States meet difficulty in the system whereby cotton at primary markets is bought at flat prices without sufficient regard to the quality of individual bales. Producers have small encouragement to grow better fiber when they have no assurance that they will get more for good fiber than their neighbors will get for poor. Manufacturers gladly pay premiums for superior cotton. The effect of this action on production practice is negligible when the premiums at central markets are not reflected in the prices paid at country markets.

In 1928-29 premiums paid in the central markets for white grades above Middling were reflected in price differences at local markets in a proportion varying from less than 20 per cent for Strict Good Middling to less than 50 per cent for Strict Middling. Of the discounts established in the central markets for white grades below Middling, the proportion reflected in the local markets varied from about 40 per cent for Strict Low Middling to about 75 per cent for Good Ordinary. Only 12 per cent of the discounts made in central markets for cotton having a staple length of thirteen-sixteenths of an inch or less was reflected in local price differences. Staple premiums in the central markets were reflected to growers at local markets in proportions varying from less than 15 per cent for fifteen-sixteenths of an inch cotton to less than 40 per cent for cotton with a staple length of $1\frac{1}{8}$ inches. In other words the central but not the local markets discriminated with some nicety between the different quality cottons produced. This situation obviously penalizes the grower of superior fiber and retards the production of better-quality cotton.

THE LIVESTOCK SITUATION

The livestock situation was favorable at the beginning of 1930, but adverse conditions developed as the year advanced. Returns to livestock producers fell far below those of 1929. In the case of cattle and hogs, a decline in the demand was the principal difficulty. Cattle numbers in January were only slightly above the low point reached in 1928, and cattle slaughter seemed not likely to exceed that of the previous year. Hog production had been reduced and a marked reduction in hog slaughter was in prospect. Only in the sheep industry were there indications of overexpansion. Yet the prices for all three classes of livestock dropped greatly, the sheep industry suffering particularly because it had to deal with an increased production as well as with a reduced demand.

Cattle prices began to weaken early in March, evidently as a result of a declining consumer demand. Weakness in the demand was particularly marked from the beginning of June to the middle of August, when unusually high temperatures prevailed over much of the country. Toward the end of July the average price of all grades of slaughter steers had fallen to the lowest level since 1926, and at the low point was 40 per cent below the average price at the corresponding period in 1929. A sharp advance took place in August and September, notably in the prices of the better grades. Early in October, however, the price level was still about 22 per cent below that which prevailed a year previously. Feeders, who had suffered losses in the spring and early summer, bought less than their usual supply of feeder animals. As a result, more than the usual proportion of market offerings went into slaughter channels.

For cattle and calves slaughtered under Federal inspection during the first eight months of 1930, producers received about \$119,000,000 less than they received for the cattle and calves slaughtered under Federal inspection in the corresponding period of the previous year. In gross value this represented a decline of 18 per cent, though the total slaughter of cattle and calves was only 1.4 per cent less. From a supply standpoint, however, the cattle industry is still in a strong position. Improvement in the demand for beef should, therefore, be quickly reflected in better prices for beef animals.

Hog producers suffered less severely. Hogs slaughtered under Federal inspection during the first eight months of 1930 numbered 29,331,018 head, or 8 per cent fewer than in the first eight months of 1929. The average price received was \$9.74 a hundred pounds, or 6.8 per cent less than in the corresponding period of the previous year. The combination of reduced slaughter and reduced prices lowered the gross return to \$670,000,000, a reduction of 14 per cent from the \$779,000,000 received for hogs slaughtered under Federal inspection from January to August, inclusive, in 1929. From the gross return in the first eight months of 1928, however, it was a reduction of only \$28,000,000.

Foreign markets for American pork and lard were relatively unfavorable. Hog numbers had increased in the important hog-producing countries of Europe, and our exports of both bacon and lard declined. Our total exports of cured pork from September 1, 1929, to August 31, 1930, were somewhat smaller than in the corresponding months of the previous marketing year. Depressed economic conditions, as well as increased hog production in Europe, reduced the demand for American hog products.

The sheep industry had to market an unusually large supply of both lambs and wool. Slaughter supplies of fed lambs from December, 1929, to April, 1930, were about a million head larger than in the corresponding period a year earlier. On a tonnage basis, the increase exceeded 21 per cent. In the first four months of 1930 the market was compelled to absorb a fourth more lambs than in the first four months of the previous year. This heavy marketing, combined with reduced consumer buying power, resulted in an average price for sheep and lambs during the fed-lamb season of only \$10.56 a hundred pounds, as compared with \$15.03 in the 1929 season. Returns to lamb feeders, despite the increase in marketings, were approximately \$10,000,000 less than in the preceding season.

These low returns curtailed the demand for feeding lambs from the 1930 lamb crop, which was 2,000,000 head larger than that of 1929. Producers were therefore obliged to sell more lambs than usual for slaughter, and prices were forced down to the lowest level in many years. In August the average prices of Good and Choice feeder lambs fell to \$6.50 a hundred pounds. The average price of Good and Choice slaughter lambs at Chicago in the first week of October dropped to \$7.52 a hundred pounds. These prices were, respectively, 50 and 40 per cent lower than the prices prevailing in the corresponding weeks of 1929. Wool prices, in the foreign as well as in the domestic market, declined during the year in about the same proportion as lamb prices. After a period of steadiness, the wool market early in October indicated some further weakness.

THE DAIRY SITUATION

From about 1921 to the end of 1929 the dairy industry of the United States was more stable and on the whole more profitable than most other agricultural enterprises. Late in 1929 and in 1930 it suffered a setback. The demand for dairy products fell off, underlying tendencies to overproduction were disclosed, feed supplies and pasturage were reduced by the drought, and feed costs advanced beyond the costs that would have prevailed but for the drought. Unfavorable conditions in foreign dairy markets affected American dairy interests, though the margin between domestic and foreign butter prices did not widen sufficiently to cause any increase in our butter imports. Since October, 1929, butter prices have been lower than in the corresponding months of the previous season and also below the 5-year average. A pronounced upturn took place in July and August, when dairy production was affected by the drought. Yet butter prices are still below those of a year ago. They seem likely to remain for a time at a lower level than that of the last few years, owing to a continuing tendency toward expansion in the industry.

On two previous occasions since the World War—in 1921–22 and in 1924–25—the dairy price situation was similar to what it is now. In those seasons, however, the difficulty was remedied by a rather prompt cut in production. The reduction came from three causes: (1) A decrease in the use of concentrated feeds; (2) increased culling of herds; and (3) a tendency among farmers, especially in the Corn Belt, where many beef cows are milked, to let the calves do the milking. Only one of these causes—a reduced use of concentrated feeds—has been noted this year. Farmers seem to have had no more profitable alternatives than dairying; hence there has not been much close culling of herds or any marked shift from dairying in the Corn Belt. Rigorous culling of low-producing cows should be profitable, especially in view of the tendency toward overexpansion in the dairy industry.

Though the drought caused a heavy drop in dairy production during the pasture season, supplies of roughage and hay are fairly ample in the more important dairy sections. Accordingly dairy production this fall and winter, though it will not be as large as it was during the corresponding periods last year, will not be as much below the

last season's level as the summer production was. More than the usual seasonal advance in corn prices is expected; supplies of oats, barley, and wheat, however, are so abundant that no extreme advances in feed-grain costs are probable. In the specialized dairy territory, where about 85 per cent of our total butter output is produced, feed supplies are not seriously depleted. Feed shortages could reduce production in other areas by as much as a third without causing more than a 5 per cent drop in our total butter production. Milk cows and heifers are increasing in numbers. It is therefore probable that the effects of the drought in curtailing production will be only temporary. Improved business conditions would stimulate the demand for dairy products, probably not sufficiently, however, to obviate the need for reducing production.

The immediate outlook for the dairy industry varies widely in different localities as a result of the varying degree in which they have suffered from the drought. Following the drought a critical situation existed in most of the Ohio Valley and in parts of a larger area extending from Maryland to southern Missouri and southward into the lower Mississippi Valley. In these areas water was scarce, pastures failed, crops were seriously damaged, and farmers began feeding their scanty supply of hay and grain earlier than usual. There has been some distress selling of milk cows. As already noted, however, the more specialized dairy regions are in better shape. In the northern dairy sections production during the winter months will largely depend, as usual, on the spread between the cost of grain and the price received for milk or cream. Where grain and hay supplies are ample, milk production may be as profitable as other livestock enterprises. Only local milk shortages are probable, and there is no scarcity of milk cows for replacement purposes. In short, the dairy industry faces the combined influence of lessened consumer demand, both at home and abroad, and a tendency toward expansion. Though it can make rather quick changes within certain limits in the volume of its output of milk and other products, it can change the supply of its basic stock only very slowly.

THE POULTRY SITUATION

Egg production in 1929 was less than in 1928, and the summer movement of eggs into storage was smaller than usual. As a result the poultry industry entered 1930 with prices generally high. As the year advanced, however, laying flocks were considerably expanded. The resulting heavy egg production, combined with a lighter demand, caused a marked decline in egg prices. In the first part of the flush production season, the demand for eggs to be placed in storage remained good. Eggs in storage accumulated rapidly, however, and on August 1 the supply was the largest on record. Egg prices dropped instead of showing the usual seasonal rise. At this writing the heavy supply of eggs in storage and the early lay of the 1930 pullet crop are depressing factors. Material improvement in the egg market, other than the normal seasonal rise, is not expected before the early part of 1931. Exceptionally good demand for baby chicks prevailed during the first few months of 1930. From February to June the production of salable chicks by the hatchery industry, according to reports received from commercial hatcheries,

was about 22 per cent above the production of the corresponding period in 1929. Some of the increase undoubtedly represented a shift from farm to commercial hatching. Returns covering about 20,000 ordinary farm flocks indicated that on July 1, 1930, chickens and young chicks of the current year's hatch numbered about one-half of 1 per cent less than on July 1, 1929. The contrast between the showing of the commercial hatchings and the showing of the farm flocks may be partly attributable to reduced hatchings on farms, heavier mortality of baby chicks, and a tendency among poultrymen to market a larger number of pullets as broilers.

The number of laying hens in farm flocks on July 1 was about 1 per cent greater than on the same date in 1929. Since then, however, relatively low egg prices have caused a fairly heavy movement of fowls to market. It is therefore probable that farm flocks in 1931 will be smaller than they were in 1930. Moreover, the current low egg prices may cause poultrymen to feed their flocks less intensively. Indications are, in fact, that laying flocks will enter the spring of 1931 in a condition below normal. Hence the total egg lay during the flush production of 1931 is likely to be less than it was in 1930. Whether the prospective decline in production will be accompanied by a proportionate rise in prices depends, of course, on the consumer demand, which is primarily affected by the business situation.

The poultry market, as well as the egg market, was oversupplied in 1930. Heavy hatchings from the preceding year and a lessened consumption demand caused a marked accumulation of poultry in cold storage. Heavy hatchings this year aggravated the situation. The movement of both old and young stock to market was very free. From January to September, inclusive, the receipts of fresh-killed western poultry at principal western markets were 3 per cent more than the receipts in the corresponding months of 1929. These liberal receipts, added to the influence of storage stocks that were nearly at the record level, caused a slump in poultry prices. However, the lower prices stimulated poultry consumption. In the first nine months of 1930 the consumption was 15 per cent heavier than in the corresponding months of 1929. Hence the prospect for 1931 is not unfavorable. Producers should find the market more nearly normal, without burdensome storage accommodations and without excessive market receipts.

THE FRUIT AND VEGETABLE SITUATION

Many fruit and vegetable producing sections were seriously affected by the drought of 1930. Some crops in the Central and East Central States were a complete failure. Others were greatly reduced. In other localities a combination of unfavorable weather at planting time and high temperatures during the harvesting period not only reduced yields but caused certain crops to mature within an abnormally short period. The result was a temporary flooding of markets, with sharp price declines. Early watermelons all matured in a short period instead of over several weeks, and shipments became so heavy that for a short time cars of melons could not be sold at shipping points at prices sufficient to cover the harvesting and loading charges.

These disasters, while of great importance locally, had but little effect upon the total shipments of fruits and vegetables for the country as a whole. The staple fruits and vegetables are now produced commercially in so many sections that a failure in a few areas does not mean a national shortage or prohibitive prices for what is produced. Even when there is a material reduction in a crop which is grown in restricted areas, such as the citrus fruits, the price is only moderately affected. The great variety of fruits and vegetables from which the buyer has to choose during practically all months of the year serves as an equalizer of prices. A material increase in the price of one results in the substitution of some cheaper product.

The rapidity of transportation and the wide distribution of market information by the department's market news service, the daily press, the telegraph, telephone, and radio are doing much to secure equitable distribution of these highly perishable products, which often are in too heavy supply in some markets while others are bare. The motor truck is doing much to equalize distribution. Overnight hauls of 250 miles or more from oversupplied to undersupplied markets are common. There is a tendency toward heavier car-lot shipments to the larger markets, from which daily deliveries of mixed truck loads are made to the jobbing houses and retailers within an ever-increasing radius. An opposite tendency, which has had some success, is an attempt to expand the shipment of mixed car-lots to the smaller cities.

The development of large terminals by the carriers and by other private capital in many of the principal markets during the last few years has done much to overcome the confusion which formerly existed because of inadequate unloading facilities and the use of the railroad car as a warehouse and a salesroom.

FARM INCOME IN 1929 AND 1930

Farm incomes from the production of 1930 are expected to be lower than for any season since 1921. The gross income from the 1929 production amounted to about \$11,851,000,000, or about \$110,000,000 greater than that for 1928, but the returns from this year's livestock marketings have to date been considerably lower than the comparable returns last year, and returns from the 1930 crops now in process of being marketed are also considerably below those obtained from the 1929 crops. The aggregate gross income from the 1930 production will probably be about \$9,950,000,000, or 16 per cent below that of 1929.

In 1929 the major farm expenditures showed very little change. Hence the increased gross income in that year resulted in an increase in net income computed as a return for the farm operator's capital and labor. The net income available in 1929 as a return for the operator's capital and labor was \$1,055,000,000, as compared with \$984,000,000 in 1928 and \$1,206,000,000 in 1925, which was the best year since the post-war slump. Farm expenditures in 1930 have been less than they were in 1929, but the reduction is small compared with the reduction in gross income.

The reduced farm incomes of 1930 follow a series of years—1924 to 1929, inclusive—in which, despite diverse conditions in different agricultural sections, the aggregate income was fairly stable. This

year all sections suffered because of world-wide industrial depression. In addition, farmers in a wide area suffered seriously from drought. In the drought-stricken area the gross farm income will be reduced about 25 per cent below that of 1929. In other sections the gross income, though greatly reduced, may be better than it would have been had the drought not lessened the country's total farm production.

Farm Prices in Relation to Farm Income

The great change from moderate improvement in 1929 to severe depression in 1930 is largely attributable to price movements since the summer of 1929. Total farm production in the fall of 1929 was not excessive, as compared with that of recent years. In August, 1929, the index of prices received by farmers was higher than in any month in the previous season and averaged 143 per cent of pre-war prices. By November the index had declined to 135 and by March, 1930, to 126. After a slight recovery in April it resumed the downward trend. A still more severe decline in the prices of practically all farm products in July lowered the index to 111. On August 15 it stood at 108, 2 points lower than the lowest level reached in the drastic deflation of 1921 and only 8 per cent above the pre-war level. The level of prices received by farmers declined nearly 30 points in one year, from September 15, 1929, to mid-September this year. With no offsetting increases in marketings this drastic decline in prices caused a 25 per cent drop in current gross farm incomes as compared with those of August and September, 1929.

Practically all branches of American agriculture received lower returns this year. Last year in August the cotton growers received 18 cents a pound for cotton; in August, 1930, they received less than 11 cents a pound for a crop believed to be slightly smaller than last year's.

Wheat growers in August, 1929, received an average of \$1.11 a bushel. This season, for a crop not much larger, the August price averaged 74 cents—37 cents less than last year's. Even the potato crop, which is expected to be the smallest since 1925, sold in August at \$1.09 a bushel, compared with \$1.39 a bushel for a larger crop last year.

Producers of livestock and livestock products fared no better. Wool at 19.8 cents a pound in August was nearly 30 per cent below the prices received in August last year. Lambs brought less than \$7 a hundred pounds, as compared with \$11.46 last year. Beef cattle at \$6.26 a hundred pounds on August 15 averaged \$3.36 below last year's prices. Hogs, which in August, 1929, brought \$10.28 a hundred pounds, sold for about \$8.50 in August this year.

The dairy and poultry industries lost much of their previously advantageous price positions. The price of butterfat on August 15, 1930, at 35.7 cents a pound, was more than 7 cents lower than in August, 1929. Eggs sold for nearly 30 per cent less and chickens for 20 per cent less. Last year, when all farm prices averaged 143 per cent of the pre-war level, poultry products averaged 151 and dairy products 137. In August, 1930, when the average of all farm prices had slumped to 108 per cent, poultry products averaged 107 and dairy products 117. As compared with the prices received for other

farm products dairy prices remained relatively high. Grains at 101 and cotton and cottonseed at 94 per cent were relatively low.

Farm prices declined more than nonagricultural prices. The average level of the wholesale prices of all commodities, according to the Bureau of Labor Statistics, declined about 15 per cent from August, 1929, to August, 1930. The wholesale prices of farm products during the same period declined 21 per cent and food 16 per cent, while the prices of nonagricultural products declined only about 10 per cent.

The prices that farmers pay for the goods they usually buy declined much less than the prices of farm products. The average of the prices paid by farmers in August, 1929, was about 155 per cent of the pre-war level. By August, 1930, the prices of these articles had been reduced to an average of 149 per cent of the pre-war level, a reduction of only about 4 per cent in the year. The ratio of prices received to prices paid was reduced from 90 per cent in August, 1929, to 72 per cent of the pre-war average in August, 1930.

FACTORS IN THE CURRENT DEPRESSION

The current slump in agricultural prices and incomes reflects the combined influence of continued overproduction in some important farm products and of the world-wide business depression. Agricultural overproduction existed before the business depression began. Its effects were heightened when the depression curtailed demand. The business depression caused a tightening of credit, a world-wide decline in commodity prices—in which agricultural prices suffered most—widespread unemployment, and a general reduction in the purchasing power of consumers. Agriculture's added difficulties this year are attributable largely to conditions outside the agricultural industry.

The year began without the prospect of increased burdensome agricultural surpluses. There was a large carry-over of old wheat in the United States, but the world's production in 1929 was below normal. It seemed likely that the United States would be able to market the increased carry-over and the new crop at prices better than had prevailed in the previous season. The cotton crop was of moderate size, as compared with the crops of 1925 and 1926, and the carry-over was not large. Fruit crops were generally short, and relatively high prices were to be expected. Prospects were for relatively small marketings of cattle and hogs at relatively high prices. Large production of lambs, wool, and dairy and poultry products was in prospect, and lower prices were to be expected, but not enough lower to constitute a material depression. There was a reasonable expectation that the prices of agricultural products in general for the season would be higher than in the previous season and that agricultural income would continue to improve. All such expectations had to be abandoned with the break in the business situation and the subsequent marked decline in prices.

Many of the factors which contributed to the decline in agricultural prices and income are related, and their influences can not be measured separately. Business activity in the United States in 1928 and 1929 was greater in some lines than could be maintained. The volume of business in the United States began to decline in the sum-

mer of 1929. The stock market turned down in September and broke sharply in November, and the break appeared to precipitate similar slumps in many other countries. Increased unemployment reduced the purchasing power of consumers. The prices of agricultural products fell not because of an increase in the supply, but because consumers were either unable to buy as much as usual or were unwilling to buy for future needs, except at lower prices.

The effect of this reversal in the business situation on agriculture was most clearly seen in the prices of cotton, butter, and meat animals. In these commodities there were no great changes in supplies. The price declines clearly resulted from a decline in the demand. A reduction in the mill consumption of cotton, both at home and abroad, was a principal factor in depressing the price of cotton to low levels in March, 1930, and to a still lower level in the summer months. The 1930 crop is slightly smaller than that of last year, but the cotton farmers are faced with a larger carry-over because of the depression. Cotton prices are about 6 cents a pound below those of last year, a decline of more than 30 per cent. The change in domestic and foreign business and the general decline of commodity prices have cost the cotton growers so far this season about \$30 per bale, or more than \$400,000,000 on the total crop.

The turn in the business situation began to affect the dairy industry in the summer of 1929, when the consumption of butter declined. Toward the end of 1929, increased production and declining demand produced record cold-storage holdings. Prices on surplus fluid milk were lowered, and butter prices not only failed to make their usual seasonal advance, but dropped to the lowest levels since 1921. Though some recovery in butter prices took place during the summer of 1930, they are still well below last summer's prices.

The reduced purchasing power of consumers was reflected also in prices for meat animals lower than those that usually prevail for such numbers as have been marketed so far this year. The combined production of all meats has been practically constant since 1924, but prices and returns to farmers for their marketings have varied with changes in the purchasing power of consumers. In 1929 the total cash income from the sale of livestock amounted to more than \$2,500,000,000. The returns in recent months have been at a rate fully 25 per cent lower. The prices received by farmers for meat animals in August, 1929, average 165 per cent of the pre-war level. By August, 1930, they had declined to 119, or a drop of 28 per cent. If business activity this year had remained on the high level of last year, the prices paid to farmers last year probably would have prevailed in general this season. Hence it appears that the business slump is probably causing the livestock producers a loss of more than \$500,000,000.

World-wide Price Decline

In some countries commodity-price recessions were in progress before the summer of 1929. In most countries the downward movement was accentuated in the last few months of that year. The combined price level for the countries that take most of our farm exports (the United Kingdom, Canada, Germany, France, Italy, the

Netherlands, Japan, and China) followed a downward trend after 1924. In the succeeding five years, until the summer of 1929, an average of their prices showed a decline of about 10 per cent. Commodity prices in the United States declined in the same period but to a somewhat lesser extent. High industrial activity in 1928 and 1929 was a sustaining influence. The decline in the United States during this 5-year period was about 6 per cent. Since July, 1929, and particularly since September, 1929, the average of commodity prices in these countries has declined more than 10 per cent.

The decline in general price levels in foreign countries has been brought about in the same manner as the reduction in the general price level of the United States. Business depressions have reduced the demand for raw materials for manufacture, such as cotton and wool. Unemployment has reduced the power of consumers to purchase foodstuffs and clothing. These conditions have affected the international market for agricultural products. Many countries have endeavored to strengthen the domestic markets for their own products by increased tariff duties and other restrictions upon imports. Countries that export agricultural products have been forced to sell at low prices. This necessity has naturally curtailed their power to buy industrial products.

It is perhaps significant that the general price declines this year in June and July did not continue in August and September, although certain key products, both industrial and agricultural, notably copper and wheat, reached new low levels in September. The reduced agricultural production of 1930 has already strengthened some agricultural prices. This in turn should help to stabilize the general commodity price trend, and tend to create more confidence in the business situation. The depression has already continued about as long as former depressions of this character. In the immediate future, however, any marked price advances are likely to reflect supply changes, rather than improvement in the domestic or the foreign demand.

AGRICULTURAL EXPORTS AND IMPORTS

Exports of agricultural commodities in the year ended June 30, 1930, were the lowest since the year ended June 30, 1915. The export index number for the 12-month period was 97. This index is based on the exports of 44 of the principal farm commodities, with the movement in the period 1909-10 to 1913-14 taken as the base. The decline in the exports was general. With cotton (which bulks so large in the total) excluded from the reckoning, the index number for the remaining commodities was 117. This was lower than the corresponding number for any preceding similar 12-month period since 1913-14. The index for cotton calculated separately was 82, the lowest in six years.

These figures reflect essentially the volume, not the value, of the exports, though values are considered in the weighting of the index. In value the agricultural exports of the United States were 19 per cent lower in 1929-30 than in 1928-29. Lower prices diminished the unit value of the goods exported, and increased world competition lessened the foreign demand for United States crops. Excluding forest products, our agricultural exports for the year 1929-30 were

\$1,495,000,000, against \$1,847,000,000 in the previous year. Agricultural products constituted only 32 per cent of our total exports, as compared with an average of 40 per cent in the period 1925-1929.

The dominant factor in reducing the value of the exports was a smaller movement of cotton at a lower average price. There were also substantial decreases in the value of the exports of grains, fruits, animal oils and fats, vegetable oilcake and oilcake meal, and dairy products. Tobacco made the best showing. In quantity the tobacco exports increased notably and in value slightly. Exports of meat were higher in both volume and value. Lard exports were larger but the total value was less.

Cotton exports (excluding linters) were 7,097,000 bales, valued at \$667,251,000. This was a decrease of 19 per cent in volume and of 26 per cent in value from the annual average for the period 1925-1929. Germany again displaced the United Kingdom as the principal outlet for American cotton. It took 1,770,000 bales, or 25 per cent of the total exports, whereas Great Britain took only 1,307,000 bales, or 18 per cent. Much cotton credited to Germany in the exports statistics, however, is reexported to other European countries. Japan took 1,078,000 bales. As compared with the figures for the previous year, cotton exports to Germany declined 6 per cent, those to the United Kingdom 32 per cent, and those to Japan 21 per cent. Only France among the principal cotton-importing countries took more than in the previous year.

Exports of wheat decreased slightly and those of other grains heavily. The movement of wheat and flour was lower than in any year since 1914 except 1918 and 1926. It was 20 per cent less than the average annual movement for the period 1925-1929, though only 6 per cent under the movement in 1928-29. Japan took the equivalent of 9,863,000 bushels, or more than double the amount taken in the previous season. China, on the other hand, took less. The net gain in the shipments of wheat to the Orient was 2,023,000 bushels. Rye and rye-flour exports amounted only to the equivalent of 3,000,000 bushels, the lowest figure since 1914. This was a decrease of nearly 89 per cent from the average of the five preceding years, though the production for the season was only 14 per cent less. Rice exports were only 10,401,000 bushels, as compared with 14,137,000 bushels the previous year. The decline was particularly marked in the exports of California rice. Drastic declines were recorded in the exports of feed grains. Exports of corn and corn meal were 10,280,000 bushels, the lowest since 1925. Oats exports dropped to 7,966,000 bushels, the lowest since 1914. Exports of barley, including malt, were only 24,054,000 bushels, or 33 per cent less than the annual average for the period 1925-1929, despite the fact that barley production in the United States in 1929 was the second highest on record.

Most classes of meat exports showed an improvement both in quantity and in value. Hams, shoulders, and pickled pork were exceptions. Heavy exports to the United Kingdom chiefly accounted for the increase. About 60 per cent of all the meat exported was cured pork. More bacon was shipped than in the previous year but less hams and shoulders. As a result the total exports of cured pork were slightly under those of 1928-29 and lower than in any year since 1875. Exports of lard were about 7 per cent above the average

volume for 1925-1929 but were 12 per cent lower in value. The average price for lard during the season was lower than in any year since 1922. Exports of fresh pork amounted to 18,771,000 pounds, an increase of 23 per cent over the average for the five years immediately preceding. Shipments of beef amounted to 17,227,000 pounds. This total, though greater than the amount exported in 1928-29, was 19 per cent under the 1925-1929 average and was equal to only 14 per cent of the quantity of beef imported into the United States.

Exports of leaf tobacco exceeded those of 1928-29 by 29,230,000 pounds. They were larger than those in any preceding year except 1919 and 1920. Exports of bright flue-cured tobacco amounted to 429,942,000 pounds, a gain of 15,993,000 pounds over those of 1928-29. Exports of dark-fired Kentucky and Tennessee tobacco were 96,395,000 pounds, an increase over the shipments in the preceding two years, but a decrease from the annual average for the period 1925-1929.

Exports of all classes of fresh, dried, and canned fruit declined. The movement of both boxed and barreled apples was less than half that of the 1928-29 period. Exports of oranges and grapefruit were under those of the preceding year, but with that exception were higher than those of any preceding year. Exports of prunes were 31 per cent below the average for the period 1925-1929. Exports of raisins were 19 per cent below the corresponding average.

More vegetable oils were exported than in the previous 12 months but at lower prices. The volume of the movement, however, was less than the average for the preceding five years. Cottonseed-oil exports, though greater than in 1928-29, were 38 per cent less in volume and 46 per cent less in value than the annual average for the 1925-1929 period. Exports of linseed oil were 9 per cent below the 1925-1929 average. Exports of soybean oil were 37 per cent above the 5-year average. Exports of canned vegetables were only slightly under the record figure reached in 1928-29.

Agricultural Imports

Imports of agricultural products also declined. The value of agricultural imports, excluding forest products and rubber, declined from \$1,943,000,000 in the fiscal year ended June 30, 1929, to \$1,696,000,000 in the fiscal year ended June 30, 1930. The value of imports of all agricultural products, excluding forest products and rubber, was about the same as in 1924 and not so low as in 1922.

The principal causes of the decline in the value of imports were a decline in the prices of many products and, in some cases, a material curtailment in the demand. The reduction in the value of the imports of sugar and coffee constituted nearly half the reduction in the value of the total imports. More coffee was imported, but prices fell so much that the total value was greatly reduced. A curtailment in the manufacturing demand for such raw materials as silk, wool, and cotton subtracted about \$74,000,000 from the total imports. The value of the imports of oils and oilseeds declined \$21,000,000. Flaxseed imports were maintained, but the value of palm kernel, copra, and other coconut products reduced the total.

Rubber is not included in the above total valuation of imports. Though more rubber was imported, the value of the rubber imports was \$39,000,000 less than in the preceding year.

Imports of hogs, cattle, and sheep were reduced. A large clip and a reduced demand for wool resulted in a reduction of about \$24,000,000 in the value of the imports of carpet and combing wools. The value of the imports of dairy products was reduced by about \$6,000,000. The imports of eggs and egg products, on the other hand, increased by a small amount. The Orient sent larger quantities of the dried yolks and albumen of eggs. A short fruit crop in the United States in 1929 also resulted in a slight increase in the imports of fruits, including some increase in the imports of bananas.

OVERPRODUCTION AND CROP ADJUSTMENTS

One aspect of the farm problem overshadows all others. Production in a number of important lines is out of balance with the market, and surpluses pile up continuously. Barring such temporary fall in demand as we experienced in the past year due to world-wide business depression, our difficulty is not a sudden emergency, but a cumulative overproduction. Farm production, already above normal requirements, became disastrously excessive when the depression curtailed purchasing power. Exceptional weakness on the demand side was added to the trouble on the supply side. I want to emphasize the need for equitable, intelligent, systematic, and collective action to bring supply into better relationship with demand.

Farmers, of course, must deal mainly with the supply phase of the problem in one way or another. There are two main alternatives. They can let matters drift until production is reduced by the ruin of thousands and their elimination from the farming industry, or they can consciously direct the readjustment process to lessen its difficulty and hasten its end.

The answer to overproduction is less production. Crops must be balanced as nearly as possible with market demands and offered only in such quantities as can be sold at prices covering the farmers' cost of production plus a profit. If readjustment is not brought about by intelligent action, it will be effected through blind economic forces at excessive cost. Let us not deceive ourselves by saying that real overproduction is impossible, since all the foods and fibers produced are eventually consumed at some price. There is overproduction if the price received does not exceed the cost of production by a margin sufficient to give the reasonably efficient farmer a fair net income.

Technical Progress in Production

The growing efficiency of American agriculture helps to explain but does not justify its persistence in overproduction. Technical progress has increased farm productivity tremendously in the last 15 years, but the benefit has gone largely to the consumers. Farming has been industrialized and mechanized. It has used science, decreased its production costs, and increased its output, without finding either profit or security in the process. It has made two blades of grass grow where one grew before, only to find the second blade depressing the price of both. Continuing in this path, in the hope that still greater efficiency will eventually force our competitors out of the market, seems likely to work no better in the future than it has done in the past. Farming is becoming more efficient all over

the world, and crop acreage and livestock breeding are increasing. The competing groups know that a halt in production will have to be called, but no group wishes to be the first to slow down.

Other industries behave differently. In the first seven months of 1930 the production of motor vehicles in the United States declined 44 per cent. This decline was not compelled by bankruptcies, but resulted from voluntary concerted effort to adjust output to the demand. Low-cost as well as high-cost plants participated. They found that course better business than to go on glutting the market, in the hope of driving enough producers out of it to leave a good field for the rest. While the problem in farming is more difficult, this same logic should apply to agriculture. It does not follow, because some farmers can produce at a lower cost than others, that the low-cost farmer should do nothing to prevent overproduction. Narrow competitive views of that sort invite bankruptcy. Bankruptcy is contagious. Ruthless competition means, in the end, measuring living standards by the lowest in the scale.

World Wheat Expansion

Since wheat particularly is overabundant, let us consider the wheat situation. The world's wheat area is 42,000,000 acres larger than it was before the war. The United States has contributed 14,000,000 acres to the increase. These figures do not include Russia's acreage. Russia will undoubtedly increase its wheat exports. Wheat surpluses have piled up steadily in the last half decade, and world carry-overs reached huge proportions after the bumper crop of 1928. The current year's world carry-over on August 1 exceeded 500,000,000 bushels, though the 1929 world crop was less than that of the preceding year by almost the same amount.

Consuming countries have reduced their wheat imports by high tariffs, by forcing the consumption of substitute cereals and starches, and by encouraging their own wheat production. For instance, Germany has raised her tariff on wheat to \$1.62 a bushel. Importing countries in the crop year 1929-30 imported 237,000,000 bushels less than in the previous year. Meantime wheat growing continues to expand in the exporting countries, particularly in parts of the United States and in Canada, Argentina, and Australia. The area sown to wheat in our southwestern winter wheat States increased approximately 4,000,000 acres from 1924 to 1929. During the same period the area in Canada, Argentina, and Australia combined, increased more than 10,000,000 acres, from 49,000,000 to 59,000,000 acres. This is in line with the trend in expansion since 1910. The entire wheat-producing world faces increased acreage, increased production, and unsatisfactory prices. It is vainly trying to beat the law of supply and demand. In the last seven years it has produced an annual average of 43,000,000 bushels of wheat more than has been consumed, and the United States' carry-over has piled up to the record total of 275,000,000 bushels. This year, moreover, our wheat crop is larger than that of last year.

It is sometimes urged in defense of continuous wheat expansion in the United States that certain extensive wheat-growing areas in this country can produce wheat more cheaply than it can be produced

anywhere else in the world. Whether or not this is entirely correct we do not know. Our methods and our machinery are up-to-date, but other countries are efficient too; and some of them have much cheap and fertile land. Even if our growers are in a relatively strong competitive position, it does not follow that they should blindly offer themselves for punishment. Competition to see who can stand the heaviest losses is irrational. Live and let live is a better doctrine. Moreover, the number of relatively low-cost producers in this country is too great to justify an endurance contest among them. Their interest lies not in fighting among themselves but in combining to adjust their total output to market needs. In this task they can expect help from the Federal Government, but only if they approach it practically. By this time it is evident that supply-and-demand conditions can not be set aside by legislation, that the dumping of surpluses abroad is not feasible, that the indefinite storing of surpluses tends to prevent rather than to cause a rise of prices, that tariff duties are not effective on commodities produced largely for export, and that subsidies would increase rather than restrain production. Voluntary curtailment of production is the only logical remedy for the surplus problem.

A striking instance of world resistance to dumping has been afforded us lately by Russia's efforts to sell wheat and other products in other countries at extremely low prices. Agitation began in France some months ago against soviet dumping, particularly of wheat. As a result the Government issued a decree on October 3, which provided for the control, through licensing, of imports from Russia into France of certain merchandise, including "cereals and their derivatives," and also a number of other products, mainly food-stuffs. The license system limits the quantities that may be admitted. Similar action was taken by Belgium on October 25, under a decree requiring an import license on grains, flour, wine, and a number of other articles from Soviet Russia. Rumania has issued an ordinance understood to apply particularly to imports from Soviet Russia. It requires on imports the stamp of the country of their origin, and also a permit issued by the Rumanian trade attaché. Rumania has no such official in Soviet Russia, because of the absence of diplomatic relations between the two countries. Hence, the ordinance seems to place a complete embargo on importations into Rumania from Soviet Russia. It was recently announced that Hungary was contemplating a license system covering imports from countries with which it has no trade agreements. Soviet Russia is the only country to which this condition applies. The latest increase in Germany's tariff on wheat, though applying to imports from all countries, is acknowledged to be a move to control the dumping of Russian wheat in the German market.

Curtailment of Acreage

The curtailment of acreage, indispensable if wheat growing is again to be profitable over a period of years, can not be recommended as a blanket policy applying equally to all farmers regardless of their special circumstances. In areas specially adapted to wheat and on farms that have no other satisfactory alternative cash

crop, the problem is not the same as it is where nature or circumstances offer a choice of major enterprises. Adjusting production is an intricate process with varying applications in different regions and on different farms. Not merely the available crop enterprises but the size and shape of fields, the characteristics of the soil, the climatic conditions, and the extent to which farm operations are mechanized must be considered.

These considerations justify a flexible adjustment policy. They do not justify a refusal to make adjustments. Not every acre now growing wheat should be in that crop even in the specialized wheat areas, whose opportunities for making crop shifts are often underestimated. Whole-hearted cooperation in a concerted effort to bring our wheat industry more nearly in line with its market would disclose many useful modifications of the existing 1-crop system. It would develop forage-crop and other side lines, and eliminate many high-cost acres from wheat growing. If by leaving acres fallow a better profit can be obtained, that, in itself, is good farm economy.

There is no merit in growing a crop at a loss merely because there is no crop that might be grown at a profit. Continuing to do that may, in fact, turn one's attention away from possible profitable alternatives. The intentions-to-plant reports this fall showed that continuous expansion is not unavoidable in the wheat fields. They indicated an intention to reduce the winter wheat acreage by 4½ per cent. Whether this is a response to the price situation or to the general argument in favor of readjustment makes no difference. It shows that adjustment is possible.

Eliminate High-Cost Acres

Mainly, readjustments in acreage are necessary as a corrective of low prices. It is elementary that prices can never rise in an overstocked market. That, however, is not their sole value. Wise acreage adjustments can help to decrease the unit cost, as well as the volume of production, and thus to widen the favorable margin, when any exists, between costs and prices, or to decrease that margin when it is unfavorable. This effect is produced by the elimination of the higher-cost acres, and the concentration of the remaining production on the more productive land. In the case of a widely distributed crop like wheat, acreage readjustment would affect lands varying much in productivity. On some farms, where wheat is a rotation crop, it might be retained at a cost of production that would be prohibitive in a cash-wheat area. Everywhere, however, the general principle of the readjustment process would be the same. In each region or locality it would transfer the highest-cost acres to other uses and thus tend to reduce average costs of production. This would obviously be an important advantage in world competition.

It is not correct to say that the same result would be reached by leaving the curtailment to the free play of economic forces, as is often recommended. That course lacks scientific discrimination. It forces good land as well as poor into the discard, because it acts primarily on farmers instead of on acres. When a farmer is driven out of business, his whole farm suffers. Acreage readjustments collectively engineered have more precision in relocating production

to economic advantage. This procedure, instead of throwing much valuable agricultural land blindly out of use, makes crop shifts that maintain the farm business as a going concern, while at the same time modifying its tendency to create surpluses. Comparatively small changes, on a sufficient number of farms, have in the aggregate a great beneficial effect. All that is necessary to set this constructive force in motion is team play. Farmers must recognize their common as well as their competitive interests.

Not sentiment but logic is the foundation of this policy. If all the wheat land in America were owned by one man the problem of adjusting the output to the market demand would be easy. The owner would reduce his production when need arose, not by abandoning scientific methods or the use of machinery but by reducing his acres. Though our wheat acreage will never be owned by any one man, the problem, from the standpoint of the wheat industry, is the same as if it were, and the solution is the same. Our numerous farm operators have the same reason for not systematically oversupplying the market as an individual owner would have. At present they are engaged in destructive competition, each, by surplus production, beating down the price of the commodity for all. This is illogical and destructive.

Many farmers think production can not be controlled by controlling acres, since output depends also on the weather and on insect pests and plant diseases. Locally this is true. But taking the country as a whole production per acre is surprisingly uniform. In the last 25 years the average yield of wheat per acre has been 14.5 bushels. The highest yield was 17 bushels and the lowest 12.2 bushels, a maximum variation above the average of only 17 per cent and below the average of 16 per cent. In most of these years the yield was much closer to the average. Production, taking the country as a whole over a period of years, is primarily determined by acreage. Farmers who take a national as well as a local view of their business problems will recognize the practical application of this truth. In the long run man rather than nature controls the volume of farm production.

What has been said about wheat applies to many other farm commodities. It is easy to find objections to the policy of concerted action for the regulation of production. Like most things worth while, the policy involves labor and thought. It calls for a widespread cooperative spirit, alertness in recognizing opportunities for profitable crop shifts, close study of market prospects, and more careful farm accounting. Much farming is done unprofitably because the farmers do not count the costs. Not knowing what it costs them to grow a crop, they have a poor idea as to what it should bring them. Continuing to grow a crop at a loss merely because one's neighbor does, or through the force of inertia, is not rational production adjustment. But those who emphasize the obstacles to concerted action for the regulation of output fail to reflect that the alternative policy, namely, reliance on the competitive elimination of high-cost men and high-cost acres, has also its drawbacks. It means wholesale bankruptcies. It has the destructive wastefulness of other uncontrolled natural laws. Letting the surplus problem solve itself by progressive calamity is not creditable in a scientific age.

Goal Is to Increase Farm Profits

The final measure of agriculture improvement must be a rise in the average net farm income. There is no other satisfactory criterion. Productivity will not do, nor a rise in the quality or variety of the things produced. Nor is it admissible to be satisfied with figures showing increased investments in agricultural land or plant. Unless gain in these respects is translated into income, it is illusory from the standpoint of the working farmer. Net income, as every farmer knows, depends on two factors—costs of production and prices received. These factors vary in relative importance with circumstances, and circumstances determine which should be most emphasized at any given moment. At present, the price factor is predominant. Production in many lines is excessive, demand has shrunk somewhat, and farm commodity prices are at a heavy disparity with the prices of other goods. That is why I emphasize the supreme importance of production adjustments as a means of affecting profits favorably.

It goes without saying, however, that the other factor in net income, production costs, remains important, no matter how greatly it may temporarily be overshadowed by the price situation. Action taken to control the volume of production can not save the consistently high-cost producer. He must either get out or accept a low standard of living. If prices should show a downward trend in the next few years, not necessarily downward from the low point of the summer of 1930 but downward in the sense that the peak of the next price cycle is not as high as the peaks of the preceding ones, efficiency in farming, to keep costs down, will be more imperative than ever. So much progress in individual efficiency has been made by American farmers in recent years, however, that reiteration of its value seems unnecessary. Rising output per man engaged in agriculture shows clearly that American farmers understand the importance of keeping down their costs of production. There is one point about the subject of efficiency that may need to be emphasized. Increasing efficiency is not in contradiction with the need for reducing production. Sometimes it is accompanied by increased output, but that is not an inevitable relationship. Efficiency should reduce costs of production, while organization regulates the total volume. These two principles, far from being antagonistic, are the twin pillars of agricultural prosperity.

FARM TAXATION

Farm taxes last year continued to rise. In 1928 the real-estate tax per acre for the country as a whole was 5 per cent above the 1924 level. In 1929 it was 7 per cent above the 1924 average. The upward trend since 1924, however, has been less steep than that from 1913 to 1924. The most rapid increase in farm taxes since 1913 occurred in the period 1917 to 1923.

The ratio of taxes to land values has advanced rapidly. This is a result not only of the rise in taxes but also of the decline that has taken place in land values in the last decade. Tax levies in 1928 were \$1.43 and in 1929 \$1.46 for each \$100 of the full value of farm real estate, as compared with \$1.22 in 1924 and \$0.68 in 1913.

With lower land values, and with the usual increase in taxes, the tax rate this year probably is about \$1.50 per \$100 of the full value of farm real estate. Farm real estate taxes now equal the interest which farmers would pay at 6 per cent on a mortgage indebtedness amounting to 25 per cent of the full value of the real estate, as compared with about 11 per cent in 1913.

In the last 15 years there has been a tremendous increase in State and local expenditures in the United States, which has put a heavy strain upon the prevailing system of raising revenues. The cornerstone of that system is the general property tax. In 1922, the last year for which official data are available, the general property tax accounted for 79 per cent of State and local taxes combined, and 89 per cent of local taxes alone.

The general property tax is little more than a tax on real estate. Personal property, especially intangibles, generally escapes taxation. The inducement to withhold property from the tax rolls becomes greater as taxes increase. Hence the revenue from the taxation of personal property has diminished greatly in relation to the total value of that property. The attempt to tax personal property, especially intangibles, by means of the general property tax, is generally a failure. Accordingly it has been necessary to increase the tax rate on property that can not escape taxation. Farm property is of that kind because it consists mainly of real estate, and of tangible personal property. Tangible personalty on the farm, such as livestock and equipment, can not be as easily hidden as intangibles, such as notes, stocks, and bonds.

More so than that of other groups of citizens, the farmer's income is directly dependent upon tangible property, primarily real estate, which is readily accessible to the tax assessor. The farmer's acute tax problem results from a rapidly increasing public expenditure met by a system of taxation that places most of the burden on real estate and tangible personal property. The burden has been made heavier in recent years by a diminution in the farmer's equity in his real estate, through the increase in mortgage indebtedness and the decline in real estate values.

The remedy lies in two directions: (1) More effective control of expenditures, and (2) revision of the prevailing system of taxation, so that more revenue will be derived from sources other than general property. Greater economy is imperative in State and local expenditure, not only through the careful scrutiny of expenditures but through the consolidation of local government units and the realignment of administrative functions. In recent years more progress has been made in these respects by the Federal Government than by State and local governments.

Of the total increase in State expenditures from 1915 to 1927, 41 per cent resulted from added expenditures for education and 20 per cent from added expenditures for highways. Probably about half the total increase in taxes on farm property since 1915 resulted from increased expenditures for education and about a fourth from additional expenditures for roads. Nevertheless the rural schools are not, generally speaking, up to the standard prevailing in cities; and the roads need further improvement. It would be easy to exaggerate

the possibility of reducing farm taxes by cutting down school and road expenditures.

There is more prospect of farm-tax relief by changing our system of State and local taxation so that wealth other than real estate and tangible personalty will carry more of the load. The State governments, and to some extent the National Government, contribute to the support of schools; perhaps their responsibility in this respect is not fully recognized. Education is far less local in character than the present system of school financing indicates. The children in rural communities, many of whom are the future citizens of other communities and other States, should have educational opportunities comparable to those enjoyed by city children. This need should be met to a greater extent by taxes levied on sources other than general property and by the larger taxing jurisdictions.

A constructive position is taken by organized agriculture. By formal resolutions and otherwise the American Farm Bureau Federation and other organizations have emphasized the need for economy and urged careful study as a basis for revision of the State systems of taxation. No fixed program is applicable to all States, because their legal and economic problems vary.

Fuller information is necessary as a basis for public economy and tax revision, and farm organizations have taken steps to create permanent committees to study the problem. The American Farm Bureau Federation has also formally urged that the tax-investigation work of this department be extended. Though legally a State problem, farm taxation from a broad economic standpoint concerns the whole Nation. Organized agriculture is justified in asking additional Federal research regarding farm taxes, for sound policy in taxation requires impartial research and the translation of the results into informed public opinion.

FARM-LAND VALUES

Farm real-estate values, though not regionally uniform in the direction or the extent of their movement during the last year, continued downward, considering the country as a whole. Recessions in the year ended March 1, 1930, rounded out a decade of declines. The number of farms that changed hands through forced sales and related defaults in the 12-month period up to March 1, 1930, was high in relation to the number of voluntary transfers. Recovery in values was impeded by heavy taxation and by other factors, notably falling agricultural commodity prices.

Surveys indicated that the average decline in value per acre of farm real estate for the entire country for the year ended March 1, 1930, was approximately the same as in the previous year, 1 per cent of the pre-war value as represented by a 1912-1914 average. This compares favorably with decreases of 2, 5, 3, and 3 per cent for the years ended March 1 of 1928, 1927, 1926, and 1925, respectively. The declines of the last two years have been the smallest reported since the break following the peak of land values reached in 1920. Farm valuations were then approximately 170 per cent of the 1912-1914 level. The March 1, 1930, level was 115 per cent of the 1912-1914 average.

A significant development was an apparent resumption of the decline in the East and West North Central and the Middle and South Atlantic States, which had previously shown some tendency toward stability. In a majority of the States, declines of 3, 4, and 5 per cent replaced the declines of 1 and 2 per cent reported for the previous year. An exception was Kansas, which for the fifth consecutive year reported practically no change in the average for the State as a whole. In western Kansas much new land has recently been brought into cultivation by power machinery. This may largely account for the State's favorable showing. The averages for the Pacific and the West South Central States remained essentially stationary. Those of the New England and Mountain States increased slightly. All told, 24 States reported declines, 6 reported increases, and 18 reported no change. In the previous year 28 States reported declines, 4 reported increases, and 16 reported no change. By States, the reduced number reporting declines and the larger number reporting increases were a favorable indication. Many of the declines, however, were more severe than those of the previous year.

Forced Sales and Voluntary Sales

Taking the country as a whole, forced transfers of farm realty were nearly as frequent as voluntary transfers. Tax sales, mortgage foreclosures, sales in bankruptcy, and sales made to avoid such formal actions involved approximately 20.8 farms per 1,000 for the year ended March 1, 1930, as compared with 19.5 per 1,000 reported the previous year. A downward trend was indicated during the three preceding years. The rate of voluntary sales and trades in farm real estate was 23.7 farms per 1,000—practically the same as in the previous year. In the New England, Middle Atlantic, East South Central, Mountain, and Pacific divisions voluntary transactions were more frequent than involuntary. In the West North Central and South Atlantic States, the converse was true. In the East North Central States the two types of transfer occurred with nearly equal frequency. The number of farm bankruptcies concluded in the courts in the fiscal year ended June 30, 1929, was five and a half times the pre-war figure. Later figures are not yet available.

During the last decade a large number of farms have been acquired by mortgagees. Mortgage loan companies, insurance companies and the land banks, as well as smaller operators, find themselves with land which they must either sell, operate, rent, or leave idle. Since these agencies are not organized primarily to operate or rent farms, the pressure to sell is very strong. Buyers are largely local farmers. But the extraordinarily large supply of farms for sale and the impaired buying power of prospective purchasers do not make a strong market.

FARM-CREDIT CONDITIONS

Farm-credit conditions were unfavorable this year. Lowered farm-commodity prices interfered with the liquidation of loans, and reduced the supply of new credit in country banks. In the smaller country banks of the leading agricultural States, deposits dropped

to the lowest level since 1922. Many banks failed in parts of the Middle West and in some of the Southeastern States. Declining farm-land values affected the credit status of farmers and forced many to reduce their mortgages though they were ill prepared to do so. For the country as a whole, as previously indicated, farm-land values averaged 32 per cent lower than in 1920, and only 15 per cent above the average of the pre-war period. With allowance made for postwar changes in the value of the dollar, farm-land valuations were 20 per cent below the pre-war level. Bank loans based on the shrinking security of farmers' equities in their land were difficult to liquidate. In areas affected by the drought, credit facilities were strained, while the demand for credit, particularly for the purchase of feed, increased. Special measures, however, afforded substantial relief from this condition.

In short, the year saw the borrowing power of the farmers much reduced. This can not be attributed in any large measure to a lack of credit machinery or of credit institutions. Agricultural credit facilities have been vastly improved in recent years. The Federal reserve act, by giving greater flexibility to our banking system, greatly strengthened the country banks as well as the city banks. The Federal farm loan act of 1916 began a sound policy of farm-mortgage finance, through long-term amortization loans. The Federal land banks in 1930 had \$1,194,000,000 in loans outstanding, and the joint-stock land banks \$570,000,000. Under the agricultural credits act of 1923, 12 regional intermediate credit banks were set up to provide production credit for terms longer than those usually covered by bank credit. Though these institutions have not been as much used as was expected, they play an important part in our farm-credit system, particularly in the financing of cooperative associations. More go-between institutions are necessary to make their resources directly available to the farmers, since the law does not authorize direct borrowing by farmers from the intermediate credit banks. Some fairly large credit corporations formed to use the discount facilities of the intermediate credit system have been very successful, and there is room for more. Under the agricultural marketing act of 1929 the Federal Farm Board provides funds for loans to cooperative associations for marketing, for the acquisition of plant and equipment, and for other purposes. Credit thus supplied supplements that furnished by other agencies. Agriculture is much better served with credit facilities than it was 10 or 15 years ago.

The Risk Factor

The farm-credit problem, however, is not exclusively a problem in facilities. It is also a problem in risks. Its dual nature is evident from a study of the numerous bank failures that have taken place in recent years. More than 4,000 banking institutions in the agricultural areas have closed their doors since the postwar depression began. These failures might have been fewer had certain errors in banking methods and in banking organization been avoided. Too many country banks were chartered before 1920, and destructive competition for an insufficient total volume of business resulted. Many risks were assumed that prudent banking would have rejected. Often, too, bank managements were relatively inexperienced. In so

rapid a growth of banking institutions the supply of trained men was inadequate. Obviously, however, defects of this character explain the bank casualties only in part. The underlying cause was the agricultural depression, with its reduced farm commodity prices and its reduced farm valuations. Loans that had seemed secure when made proved uncollectible. The farm-credit problem is merely a phase of the farm problem as a whole. Healthy credit conditions demand not merely sound credit institutions but sound farm management and sound farm conditions. If the supply of farm credit is to be adequate and the cost low, farmers and bankers must unite in action to lessen the hazards of the agricultural industry.

Farm credit remains costly in many parts of the United States notwithstanding the improvements brought about by the Federal reserve act, the farm loan act, and the agricultural credits act of 1923. Regional differences in the cost of credit reflect partly differences in local credit facilities and partly differences in agricultural risks. In some areas there is room for improvement both in the facilities and in the lessening of risks. Many farmers, especially in the South, depend excessively on costly merchant credit. They do so partly because an undependable farming system discourages banking enterprise and forces recourse to the merchant, and partly because of faulty credit management on the part of individual borrowers who often use the costly merchant credit even when in a position to avail themselves of the less expensive cash loans. Studies made by the department show that the high cost of merchant credit results largely from the high percentage of losses incurred.

Field for Production Credit

There is a large field for constructive activity by banking and credit institutions to correct these conditions. Credit institutions can not be expected to make loans at low rates where agricultural hazards are extreme, but they can do something to reduce these hazards. They can urge better farm management when loans are being negotiated, and can offer special inducements for the promotion of side-line or other enterprises calculated to strengthen the farm business. Production credit furnished at reasonable rates, on conditions tending to improve the business organization of agriculture, is urgently necessary.

Credit policy should not confine itself to the exercise of a legitimate influence upon the choice of farm enterprises, but should consider also the basic financial structure of agriculture. For certain purposes it is convenient to distinguish short term from intermediate credit, and both from long term or mortgage credit. But the distinction should not obscure the essential interdependence of these forms of credit. Unsoundness in one form is quickly communicated to the others. This happens conspicuously when shrinking farm equities make difficult or impossible the funding of "frozen" short-term credits.

It is particularly important that mortgage financing should be based on careful and scientific land valuations. Too often the guide is not the current earning power of the land but its estimated selling value as security for loans. As this is reckoned on hopes for the future as well as on current realities, it frequently is wrong. More

emphasis on farm earning power is required, and the educational process necessary to effect this should reach lenders as well as borrowers. For the most part, the United States is in no present danger of a reinflation of farm-land valuations with consequent over-borrowing. In fact mortgage credit just now is too short rather than too plentiful. But there is always danger in too much reliance on estimated capital values and too little on actual earning power, as the basis for loans. Our newer agricultural areas in the Great Plains, where power machinery is farming lands formerly not capable of being profitably farmed, run some risk of this sort. Farmers in these areas should be careful not to build excessively on the results of too short a period. Practically every State in the Union made this mistake in the World War period and is now paying for it.

The Trend in Mortgage Debt

Recent studies by this department indicate that up to 1920 the volume of mortgage indebtedness in the United States closely reflected the upward trend in farm real-estate values. After the postwar slump, however, the two curves diverged. Mortgage debt continued to increase though land values fell. As a result the total farm-mortgage debt of the United States now represents about 22 per cent of the value of all farms, compared with only 10 per cent in 1910. For the year 1928 the estimated total of farm mortgage debt for the United States was \$9,468,526,000, as compared with \$7,857,700,000 in 1920, and \$3,599,000,000 in 1910. The total has continued practically unchanged during the last two years. It seems that since 1928 a halt has been reached in the long upward trend. In fact, the principal lending agencies reported a definite decline in 1928 and 1929 in the amount of their farm-mortgage loans. Some of the increase in farm-mortgage debt since 1920 represents the funding of short-term bank debt. A proportion of course represents new credit. It need scarcely be remarked that the burden upon agriculture represented by the postwar rise in farm-mortgage debt is very heavy. The part played in the creation of the burden by past errors in borrowing and lending should be carefully considered.

The criterion in negotiating any type of agricultural loan should be the amount of credit the borrower can profitably use. When the lender considers only how much it seems safe to lend on the security offered, he goes against his own interests as well as against those of the borrower. Capital values, though ultimately based on earning power, are not necessarily a true measure of earning power at any given moment: and earning power is the only source from which the debt payments can be maintained. Essentially it is the earning power of a farm that determines the limit of profitable borrowing. When farmers borrow excessively in the hope that advancing land values will enable them to pay off their obligations in the future, they run heavy risks.

It is quite impossible, of course, to lay down a general rule as to the proportion that should subsist between the farmer's own capital and the capital that he borrows. That will vary with the man, with the farm, and with the general economic and market situation. Lending institutions are, just now, perhaps too conservative in mak-

ing agricultural loans. They are naturally impressed with the practically continuous fall in farm-land values since the war and with the resulting heavy damage to themselves. Short-term as well as long-term credit sources respond in the same way to the postwar situation. Country-bank failures counsel conservatism powerfully. It does not follow, however, that the prevailing conservatism is wise. It may be merely a blind reaction from the preceding excessive liberality. More attention is paid to earning power in negotiations for short-term credit than in long-term credit operations, but even in the short-term field the prevailing influence is the memory of recent losses, rather than a sober study of current opportunities. When credit can be profitably used it should be furnished. In such circumstances it is wasteful to withhold it, just as it is wasteful to extend credit for which there is no profitable use.

Common Interest of Lender and Borrower

Increased farm earnings, though indispensable, are not all that is necessary to make agriculture prosperous. The producer must retain a fair share of the increase. In other words, care must be taken to see that capital charges are moderate. Farmers can not succeed when interest, rent, and other fixed charges continually absorb an increased proportion of the farm income, as has happened in recent years. It is necessary to maintain a correct relationship between capital charges and what is called labor income, or the margin left after interest, rent, operating expenses, and taxes have been paid. The first essential is to estimate farm earning power with approximate accuracy, so that land prices and mortgage debt will not discount speculative hopes excessively. Borrowers and lenders have an equal interest in bearing this truth in mind. Since current income is the only source from which debt can be paid, it profits nothing in the long run to burden agriculture with more capital charges than its current income can sustain.

LAND UTILIZATION

How to make a better use of our land resources is a pressing problem. It would demand attention even if there were no crisis of overproduction. It is not simply a question of finding new uses for farm lands whose products can not now be profitably sold, but of allocating various types of land to the most advantageous ends.

In the United States we have a domain of nearly 2,000,000,000 acres, of which about 400,000,000 acres are classed as employed for cultivation. But if needed we could use nearly a billion acres for crop production. This is about half the total area of the Nation. In a general way our crops are grown in the areas to which they are best adapted; but a much better adjustment than that brought about by trial and error is possible. Heretofore much land has been occupied in ignorance of better lands elsewhere, as well as of progress in agricultural technic, and is now unprofitable. Much land has been put into crops that should have been left in grass or forest. Large areas have been settled under conditions that invited failure. The time has come to correct some of the mistakes of the past and to take precautions against similar mistakes in the future.

A profitable agriculture, however, can not be brought about merely by correction of past errors. It is becoming necessary to reshape the very foundations of the agricultural industry. Nothing less will accommodate it to the pressure of the powerful economic forces affecting supply and demand conditions. On the demand side, for instance, the displacement of work animals by power-driven machinery is removing the need for many million tons of corn, oats, and hay. Changes in diet are lessening the demand for certain products and increasing the demand for others. The American people are eating less bread, less corn meal, and less cereal foods per capita than they did 10 years ago. They are consuming more milk, more pork, more sugar, and possibly more fresh vegetables and more fruit. Export demand is narrowed by the recovery of European farm production from the effects of the war. Pre-war levels in production have been regained in most European countries and surpassed in some. Europe seeks greater self-sufficiency also through import restrictions. This year world-wide business depression has further weakened the agricultural markets.

On the production side technical progress is bringing extensive semiarid areas into cultivation not only in the United States but also in Russia, Canada, Australia, Argentina, and elsewhere. Labor-saving machinery is promoting the cultivation of low-yield areas that formerly could not be profitably cultivated. American agriculture, always more economical of labor than of land, is pushing this principle to a new high level. Yet it has, of course, no monopoly on efficient farm technic. Production is outrunning consumption in most of the world. Argentina is now the leading corn-exporting country and has four times the corn acreage it had in 1900. Its exports of beef in 1929 were nearly a hundred times greater than ours. Exports of butter from New Zealand, Australia, and Argentina have increased sevenfold since 1900, and last year exceeded 350,000,000 pounds. Australia's wool production in 1929 was twice what it was in 1900. Russia is exporting wheat again. With a population only 20 per cent greater than that of 1900, the world's wheat and rye production is now something like 40 per cent greater and its production of corn, oats, and barley, taken together, about a third greater.

Seven Major Objectives

These conditions emphasize, though they do not create, the need for a rational land-utilization policy. Such a policy (1) calls for a scientific classification of our land resources, so that crop, pasture, and forest requirements may be more efficiently met. Knowledge of land resources is indispensable to the wise direction of production. (2) The contraction of farm acreage is necessary in some areas, and a check upon its expansion is necessary in others. (3) Steps should be taken by public agencies, local, State, or Federal, to divert tax-delinquent lands or lands obviously submarginal for farming purposes to other than farm uses. (4) Our national reclamation policy should be reconciled with the need of restricting farm production. (5) Public reforestation should be pushed. (6) Our public-domain policy should equally serve the interests of the local farming and grazing industry, the interests of agriculture as a whole, and the

interests of the Nation. (7) Information should be made available to guide private enterprise in land settlement.

These points need not all be discussed in detail, though one or two may be amplified. It is particularly important to foster the contraction of farm acreages in unprofitable areas and to discourage expansion in others. Recent technical progress in American agriculture has changed our agricultural map considerably. Expansion in some areas has created distress in others. This is one of the inevitable penalties of progress. Specialized cotton growing on large farms in Texas and Oklahoma has put a heavy handicap on extensive areas in the Old South where boll-weevil infestation is heavy. Tractors and combines have caused a marked concentration in the production of wheat in the Great Plains area. In the States to the east wheat growing has declined.

Farming by the old methods, in fact, has become unprofitable in extensive areas, and much acreage has been abandoned and become tax delinquent. Often, however, the abandoned farms are resold instead of being excluded from crop production. It should be an essential aim of our agricultural policy to facilitate the withdrawal from agriculture of acreages that seem likely to remain unprofitable. Public provision should be made for the utilization of this land for purposes other than farming. This is not possible in many States under existing laws, which generally provide for the resale of tax-delinquent lands. There seems to be an opportunity here for Federal cooperation with State and local governments to promote the economic stability of distressed areas. A study should be made to determine what classes of land are ill-adapted to private cultivation, grazing, or timber growing, and to indicate what benefits might be derived from the public acquisition of such areas.

The States should take the leading part in acquiring lands unsuited to private utilization; in fact, several are progressing in that direction. In most States, however, lack of funds or other difficulties prevent such action. The Federal Government might well cooperate with the States through a system of Federal aid to acquire lands suited to forestation, and it might cooperate with State and local governments in consolidating tax-delinquent and similar lands into administrative units.

The public acquisition of idle lands, though in contrast with our historic land policy, seems justified by present conditions and by changing national objectives. Land not immediately needed for crops or pasture often suffers under private ownership or control. Private interests seldom do much to protect stream flow, to prevent erosion, or to conserve game and fish. Often, under the pressure of heavy carrying charges, they try to push idle land into agricultural uses, whether that is economically sound or not. This is easy in times of temporary agricultural prosperity, but the practice leads to distress. Public ownership of lands that can not be profitably farmed would, in many areas, mean a better economic use of the lands in question, and also do something to relieve the pressure of unneeded production upon the markets.

Our land-utilization policy should also tend to prevent unnecessary and ill-advised farm expansion. Most of our potential crop land is in private ownership, and to prevent mistakes in employing it for farming when the owners wish to promote that use is difficult.

It should be possible, however, to discourage ill-advised expansion. Farmers may easily be misled about the character of lands that they do not know. An information service to tell them about the economic possibilities of different areas would be a restraining influence. It is true that no agency can make infallible judgments about agricultural possibilities. Much better information could be made available, however, than that on which intending settlers commonly rely. Heretofore little has been done by public agencies to direct agricultural expansion. The opportunity to do so in the future should not be neglected. In this field the Department of Agriculture and State agencies should work in close cooperation.

Economic Problem of the Public Domain

In the past we have neglected the opportunity for helpful guidance when new lands in the public domain were made available for settlement. The responsibility for selecting his land has been placed largely on the settler himself. Some safeguards were provided in the grazing homestead act of 1915, but these did not prevent much poorly judged settlement. Our homestead policy in the last two decades has stimulated overproduction and caused heavy losses to homesteaders. Little land remains in the public domain suitable for cultivation, but the homestead policy still has a tendency to encourage uneconomic farm expansion. The danger would be increased should land now in Indian reservations be thrown open. Research to show the economic feasibility of using different areas for agriculture and the amount of land requisite for an economic unit and wide publication of the results must be the mainstay of any program for the better control of agricultural expansion, whether in the public domain or in private hands.

Relation of Reclamation to Farming

In our Federal reclamation policy it seems highly desirable to weigh the advantages of local or regional development against the disadvantages of promoting excessive agricultural expansion. Many proposed reclamation projects involve nonagricultural considerations, such as flood control and the development of water power. Such projects obviously can not be judged exclusively from an agricultural standpoint. Moreover, the number and scope of such projects seems likely to increase. The Nation is working gradually toward comprehensive flood control in place of piecemeal local drainage and levee construction. This broad policy should be more efficient and economical than the one it replaces. There are, however, many reclamation projects under discussion that should be considered primarily, if not exclusively, from the standpoint of agricultural welfare. It is a serious question whether in view of the existing overproduction in agriculture it is advisable to promote agricultural expansion through irrigation and drainage. The Federal reclamation policy involves a direct subsidy to agricultural expansion in the form of interest-free loans. This subsidy policy seems inconsistent with the efforts now being made by the Federal Government to restrict agricultural production. Studies of our land requirements which take into consideration the available land areas, the probable growth of

population, the trend in consumption, technical progress in agriculture, and foreign-trade prospects indicate that the present need is not agricultural expansion but contraction. For a decade at least our chief task will be to prevent too rapid an expansion of the arable acreage.

Reforestation

Reforestation will be more fully discussed later, but I mention it here because reforestation is a fundamental part of the land-utilization problem. Our reserve of timber, though fast shrinking, is still large enough to prevent timber prices from rising sufficiently to stimulate private reforestation. Hence, though private reforestation should be encouraged where it operates on a basis of sustained yields, the foundation of reforestation in the United States must be public action. Fortunately, it is now generally acknowledged that the public ownership of forest lands is desirable. Many countries where timber is scarce and dear, and where in consequence private enterprise might seem to be attracted to reforestation, have more of their forests publicly owned than has the United States. Japan has more than 60 per cent of its forest land in public ownership and Germany more than 45 per cent. Italy and Rumania each has more than 50 per cent of their forest land in Government hands. Some of the newer countries also have followed the policy of retaining a larger proportion of the forest area in public ownership. Thus, Canada has 90 per cent and Australia and New Zealand nearly 80 per cent each.

The United States has more than half a billion acres that could be devoted to timber growing without detriment to farm development. Much of this land may become a neglected waste of small value unless our public reforestation program is greatly enlarged. Some abandoned farm land is growing up to brush and timber of low utility, and the lack of an individual or public interest in its protection against fire makes it a menace to other more valuable areas. Public reforestation is imperative for several reasons. It is necessary to promote timber production, to protect stream sources, to check erosion, to provide recreational facilities, and to utilize land resources that would otherwise produce little or nothing.

FIELD RESEARCH IN FARM MANAGEMENT

There have been many discussions, but too few demonstrations, of sound farm-management principles. This is true in part because our experiment stations have not been able to demonstrate the best labor practices for a certain crop in a given area and year, for instance, as well as they have demonstrated the quantity of nitrogen, potash, and phosphorus needed to grow that crop on a given soil. We have talked about the size of farms, the size of fields, the location and topography of farms, the use of one farm practice rather than another, the use of machinery, and so on. Practical tests of all these economic and production principles on individual farms would be desirable. Many farmers have developed their own systems of farm management—largely by trial and error. The cost of trial and error is high. Its results are not always the best. It would undoubtedly be helpful if the State and Federal experiment stations

could expand their operations to include research in farm management in the field on land specially set aside for the purpose.

The object of improvement in farming is a high standard of living. To obtain this, agriculture must be profitable. This has long been recognized as a matter of public concern. It is now to the public's interest, as well as to agriculture's interest, to encourage economic research as vigorously as we have encouraged the research in the technic of production, without diminishing our efforts in the latter field. On farms given wholly to experimentation and demonstration we could test the soundness of various farm practices and farm-management methods.

MOVEMENTS OF POPULATION

Movements of population from the farms to the cities and from the cities to the farms of the United States, though still very large, have decreased somewhat in the last few years. The movement to the towns and cities, according to surveys made by this department, comprised 1,876,000 persons in 1929, 1,923,000 persons in 1928, 1,978,000 persons in 1927, and 2,155,000 persons in 1926. In 1929 the total number of persons who went to the farms from the cities was estimated at 1,257,000; in 1928, 1,347,000; in 1927, 1,374,000; and in 1926, 1,135,000. The net cityward movement was 619,000 in 1929, 576,000 in 1928, 604,000 in 1927, and 1,020,000 in 1926.

These figures do not indicate the net loss of farm population. The latter figure is determined not only by the ebb and flow of population between the country and the town, but also by birth and death rates. As the birth rate on the farm is much higher than the death rate, the annual loss of farm population is less than the net annual migration. For 1929 the net loss of farm population is calculated at 269,000 persons, for 1928 at 208,000 persons, for 1927 at 193,000 persons, and for 1926 at 649,000 persons. The estimated farm population of the United States as of January 1, 1930, was 27,222,000, as compared with 27,491,000 on January 1, 1929, 30,200,000 on January 1, 1922, and 32,076,960 on January 1, 1910.

Our farm population has been a declining proportion of our total population for many decades. This is partly a result of increasing farm efficiency, which enables fewer men to produce a given quantity of food and fiber. Some migration to the cities is therefore inevitable and desirable. It lessens agricultural competition, while broadening the urban market. In recent years, however, the cityward movement has been excessive, as is evident from the magnitude of the return movement. A smaller migration, had it been more definitely in one direction, would have sufficed for the necessary redistribution of population between town and country.

The slight decline in the total population movement both ways in the last few years—3,133,000 in 1929 and 3,290,000 in 1926—indicated, up to the present year, a gradual stabilization of economic conditions, an increasing permanence in the adjustment of persons to their occupations. Too much scurrying backward and forward betokens social and economic maladjustment. We seem very slowly to be getting away from that evil.

Always, no doubt, there will be a considerable movement both ways. Progress in farm technic will progressively release men from agriculture. On the other hand, many city persons will be drawn to agriculture. Some will inherit and others will buy farms. Many farm people who try city life will find themselves unsuited to it and will return to the country at the first opportunity. It is well to keep the doors swinging freely. Just how much ebb and flow of population between the farms and the towns is desirable depends on economic and social factors so complex and numerous that they can not be measured. This much we can say with certainty: Population movements as large and conflicting as those of recent years betoken economic disorder. What effect the current world-wide depression will have on population movements will be indicated by the 1930 census.

THE TARIFF ACT OF 1930

The tariff act of 1930 came in answer to the growing sentiment that a protective tariff must become more and more an integral part of our national agricultural policy. Three substantial reasons for this point of view present themselves.

In the first place, tariff protection is of increasing importance to agriculture in the United States because agriculture is becoming less dependent on foreign markets and more dependent on home markets. Fifty years ago farm products comprised 80 per cent of all our exports; to-day they comprise less than 35 per cent. Similarly, our agricultural exports are becoming a smaller percentage of our total domestic farm production. At the turn of this century we exported about 24 per cent of the total value of animal products and of crops not fed; to-day we export well under 15 per cent. There is every reason to expect that this trend will continue and that the domestic market will grow in importance to the domestic producer.

Protects Domestic Market

In the second place, competition in farm products in world markets has increased enormously. Wheat, to name only one of many examples, has increased 40 per cent in world production since 1900, whereas world population has increased only 20 per cent. Products from new lands, produced by cheap labor, fill the market places of the world. And yet the world is far from its productive limit. An additional obstacle to surplus-producing countries has been the steady increase in import duties in Europe, the principal importing area for products which compete with our farm products. A report by the United States Tariff Commission on 14 major agricultural products reveals, for 1929, a widespread increase in import duties and milling restrictions throughout Europe. The height to which import duties on farm products have risen throughout the world is startling. The duty on wheat is now 74 cents a bushel in Spain, 85 cents in France, 87 cents in Italy, and \$1.62 in Germany. Our duty is 42 cents a bushel. On barley our duty is 20 cents a bushel; foreign duties go as high as 66 cents. On corn our duty is 25 cents

a bushel; foreign duties reach 48 cents a bushel. On bacon our duty is $3\frac{1}{4}$ cents a pound; foreign duties reach 13 cents a pound. On lard our duty is 3 cents a pound; foreign duties reach 6 cents a pound. On butter our duty is 14 cents a pound; foreign duties go as high as 27 cents a pound. Sweetened condensed milk imported into the United States pays a duty of $2\frac{3}{4}$ cents a pound; foreign duties go as high as 26 cents a pound. On unstemmed leaf tobacco our import duty is $\$2.27\frac{1}{4}$ a pound; foreign duties go as high as $\$5.49$ a pound.

Under these conditions our domestic market is of the utmost importance. The tariff act of 1930 is the best means available of preserving the American market for American farmers.

Helps Balance Production

A third reason why agriculture places increased reliance upon the tariff lies in the tariff's value in helping balance production against market demand. By improving the domestic market for products which might be raised in greater quantity in this country the tariff will permit shifts from surplus to deficit crops. For instance, we import vegetables which it requires 388,000 acres to produce; dairy products and by-products which it requires 450,000 acres to produce; cattle, hogs, and sheep which it requires 818,000 acres to produce, and so on. The total shift in acreage from crops of which we now produce a surplus to crops to which increased tariff protection offers a better market could run as high as 10,000,000 acres. Farmers contemplating such shifts should of course figure relative production costs closely.

It is not surprising, then, that the American farmer is to-day taking a far greater interest in the protective tariff than he once did. His interest in the recent tariff legislation was vigorously voiced through his organizations. He looked to the tariff act of 1930 to remove some of the disparity between the protection afforded industry and the protection afforded agriculture. The tariff bill as enacted should give him considerable satisfaction.

Measured in terms of equivalent ad valorem rates, the average rate for all 15 schedules of the tariff was increased from 33 to 40 per cent, a gain of 7 points, or 20 per cent. The average rate for Schedule 7, agricultural products and provisions, was increased from 20 to 34 per cent, a gain of 14 points, or 69 per cent. This is by far the largest increase for any schedule in the tariff act. In other schedules of direct interest to agriculture there were the following increases: Sugar, molasses, and manufactures of them, 14 per cent; wool and manufactures of wool, 21 per cent; spirits, wines, and other beverages, derived principally from agricultural products, 30 per cent. Fifty-four per cent of the items in Schedule 7 bear higher import duties now than in previous tariff acts. This increase is greater, both in number and percentage, than the increase in any other schedule with one exception—wool and wool manufactures. In that schedule, also of direct concern to agriculture, increases affected 79 per cent of the items.

The tariff act of 1930 includes substantial increases in duty on cattle, meats and meat products, hides, wool, long-staple cotton, flaxseed, soybeans, butter and cheese, milk and cream, casein, eggs and egg products, sugar, and a long list of fresh fruits and vegetables.

Many of these rates, such as those on wool, eggs, long-staple cotton, and dairy products, will be generally beneficial. Others will be of maximum assistance in border markets and under favorable market conditions. All will help hold the home market for the American producer and add to the economic urge to agriculture to balance its production against the market demand.

Increases Favor Agriculture

This protection would, of course, be fictitious if the rates on the things the farmer buys were increased as much as the rates on the things he sells. I have already indicated, however, that the average increase for all schedules in the tariff act was only 20 per cent, in terms of equivalent ad valorem rates, whereas items in the agricultural-products schedule were granted increases averaging 69 per cent. The point can be illustrated by this concrete example:

The average farm family's annual budget amounts to \$1,159, studies by the Department of Agriculture indicate. In order to test the effect of the tariff upon this budget the new rates have been applied to it. The rate on each item was then weighted by the expenditure for that item to get a weighted tariff rate. We find that the weighted average tariff rate on commodities bought by farmers was 16 per cent by the tariff act of 1922 and is 20.2 per cent by the tariff act of 1930. The maximum possible increase in the farmer's budget appears, therefore, to be around 4 per cent, or about \$48 a year.

Stated in round numbers and assuming that the rate increases on farm products are entirely effective, the average income per farm on the basis of 1928 production and prices would be increased by about \$150. The average expenditures per farm—assuming, again, that the tariff rates are fully effective—would be increased about \$48 by increases in duties on the things the farmer buys. The net balance resulting from the new tariff rates, therefore, would be about \$102 per farm in favor of the farmer.

Neither the increases on the commodities the farmer buys nor on those he sells will be fully effective. But the foregoing analysis is sufficient to demonstrate that, so far as tariff protection can go, the farmer is in a stronger position by virtue of the 1930 act.

FOREIGN AGRICULTURAL SERVICE

A much-needed expansion of the foreign service of the Department of Agriculture is provided for by a new act of Congress, Public, No. 304, approved June 5, 1930. This measure directs the Secretary of Agriculture to (1) acquire information regarding world competition and demand in agricultural products; (2) investigate farm management and economic phases of agriculture in foreign countries; (3) demonstrate standards for cotton, wheat, and other American products; and (4) appoint representatives of the Bureau of Agricultural Economics as officers of the foreign agricultural service of the United States. These officers will be attached, through the Department of State, to the diplomatic missions of the United States, or to the consulates of the United States in the countries where they are stationed. The measure recognizes the increasing need of precise and extensive information about foreign agricultural conditions.

Heretofore information about foreign crops and markets has been fragmentary and often inaccurate. Many Governments do not report upon the agricultural activities of their countries, and some that do report the subject inadequately or in terms that are not satisfactory for comparative purposes. Supplementary field work by trained observers, as contemplated under the new law, should add much to the practical value of our foreign crop and market reports.

This department spends annually more than \$2,000,000 on domestic crop and livestock estimating, on price analysis, and on market news distribution. Similar work on foreign conditions is necessary to supplement the domestic information. Farm-commodity prices within the United States often depend as much on conditions abroad as on conditions at home, and an economic information service that does not broadly cover foreign conditions obviously can not fully answer its purposes. American farmers can not adjust their production intelligently to market requirements if they are in the dark about foreign demand and foreign competition.

Correlation of Foreign Work

Prior to the enactment of the new legislation this department maintained a foreign agricultural information division with resident representatives in London, Berlin, Shanghai, and Marseilles. Subsequently a resident representative was stationed in Belgrade to cover the Danube Basin. Resident agricultural representatives are to be stationed in South America, South Africa, Australia, India, and the Scandinavian countries. In addition, specialists will be assigned to study the world situation with respect to specific commodities, notably cereals, cotton, tobacco, wool, fruits, livestock and meats, and dairy products. Work done by the department's foreign information service will be correlated as closely as possible with similar work in the Consular Service of the State Department and in the offices of the Department of Commerce in foreign countries. For this purpose a committee has been appointed, with the Department of State, the Department of Agriculture, the Department of Commerce, and the Federal Farm Board each represented by one member.

The International Institute of Agriculture, at Rome, furnishes considerable material on agriculture in foreign countries. Adequate world reporting on important commodities will require at least 10 foreign posts to cover the important producing and consuming areas. In short, the situation calls for a national organization to interpret crop and market data in terms of prospects for American agriculture. This need the new legislation should in large measure supply. A knowledge of world conditions in regard to acreage sown, crop conditions, harvest yields, stocks, numbers and kinds of livestock, and prices, together with information on present and prospective demand conditions, is the aim.

REGULATING TRADE IN PERISHABLE PRODUCTS

Regulation of the trade in fresh fruits and vegetables is provided for by an act of Congress passed this year, Public, No. 325, approved June 10, 1930. This law, designed to suppress unfair and fraudulent

practices, prohibits fraudulent charges, improper rejections, failures to deliver, discarding or dumping of products without reasonable cause, false reporting about shipments, failure to account correctly for shipments, misrepresentations as to the origin of shipments, and the removing or altering of tags representing Federal inspection. It provides for the licensing of commission merchants, dealers, and brokers, and authorizes the Secretary of Agriculture to reject or revoke licenses for violation of the act. It also gives the Secretary authority to order the payment of reparations to injured parties. Civil suits may be entered in the courts to compel the fulfillment of such orders.

The act gives permanent authority for the department's fruit and vegetable inspection service. All branches of the fruit and vegetable trade, as well as organizations representing the producers, indorsed the principles of this legislation. The Food Administration during the World War period required all handlers of fruits and vegetables to take out licenses; the results of this system were generally satisfactory. It lapsed, however, with the return of peace. Shippers and others have urged its restoration through permanent legislation. Both shippers and receivers of fruits and vegetables have sought protection against unethical practices and against difficulties created by the lack of uniform methods for the settlement of disputes. These requests became so insistent that many bills designed to meet them were proposed before the present one was adopted. Though it has been in operation only a few months, it has done much good already. Notably it is causing some formerly haphazard phases of the fruit and vegetable industry to be brought under contractual relationships. Incomplete and indefinite contracts are a common cause of misunderstanding between shippers and receivers of fresh fruits and vegetables. Cooperative associations, as well as private merchants, dealers, and brokers, are required to take out licenses. Individual producers, however, are not obliged to if they sell only produce of their own raising. A person buying produce solely for sale at retail is not considered a dealer within the meaning of the act, unless his annual purchases exceed 20 carloads. These are the only exceptions to the operation of the measure in interstate and foreign commerce. Essentially all that the act requires of the licensee is square dealing and proper records. It will not interfere with the proper conduct of his business, but will make it less hazardous by reducing the frequency of disputes.

CENSUS OF AGRICULTURE

The agricultural census, taken this year in connection with the decennial census of population, will furnish much more complete information than did any of the preceding agricultural censuses. Besides giving particulars about crop acreages, classes of livestock, landlords and tenants, farm valuations, and so on, it will go into detail about certain phases of agriculture not previously covered in census material, or covered less fully, such as farm incomes, expenditures for operating, equipment, taxes, farm mechanization, soil erosion, and movements of agricultural population. It will furnish a classification of pasture lands, statistics on milk production and poultry production, and on the use of home conveniences in farm

homes, and new data on the value of farm products, which will afford a basis for classifying farms by types of farming. Census information is foundation material in the department's economic services to agriculture, and the broadened scope of the present census will make it exceptionally valuable.

As yet the only information for all States available from the census is the count of farms. This indicates that the number of farms has continued to decline in most parts of the United States since 1925. For the country as a whole the decline is about 1 per cent, or much the same as the decline between 1920 and 1925. The most notable decline in the number of farms is indicated in New England, New York, New Jersey, and Pennsylvania. In these States, however, the indicated decrease may partly reflect changes in the decisions of the enumerators as to what places should be called farms. The census taken in 1925 was exclusively an agricultural one. It therefore tended to include as farmers many persons whose main occupation may not have been agriculture. The 1930 agricultural census, since it was taken in conjunction with the general census, probably registered more precise occupational discriminations. The census instructions this year, as in prior years, provided that no place producing less than \$250 worth of products annually should be enumerated as a farm, unless it exceeded 3 acres in size; but the instructions with reference to farm population added, "and which is also locally regarded as a farm." In Massachusetts, for example, it has been estimated that there are only about 13,000 real farms, but, in addition, that there are about 50,000 small home places, mostly along the main highways, which produce small quantities of milk, poultry, and garden truck. Many of these small places undoubtedly were included in the census of 1925 and excluded in the 1930 census.

In other parts of the country where the number of part-time farmers is relatively small the decline recorded by the census in the number of farms is undoubtedly real. This is true of Kentucky, Ohio, Indiana, and Illinois. A decline for those States is recorded of from 5 to 15 per cent since 1920. A decline has taken place also in South Carolina and Virginia. In the western Corn Belt, and in the wheat regions generally, the number of farms has remained about stationary. The same is true of the Rocky Mountain States and the Pacific Northwest States. The number of farms has increased in Oklahoma, Texas, Louisiana, Arkansas, Mississippi, North Carolina, Arizona, and California. There has been a partial recovery in Georgia from the great decrease that took place in that State between 1920 and 1925. Power farming, particularly in the Great Plains States, has made many large farms; in other parts of the country the automobile has brought into existence a greater number of small farms.

World Census of Agriculture

Much important basic information for world crop reporting will be obtained from the world census of agriculture which is being taken this year. Practically all governments have promised their cooperation. In the last 25 years only 37 countries have taken an agricultural census. These 37 countries represent less than half the land area of the world and only about 30 per cent of its population.

Moreover, the censuses they took varied in dates and in methods used. Their lack of uniformity made them not very valuable for statistical purposes. In the world census now being taken, three uniform schedules, drawn up by an international committee, are employed. One is an extended schedule for the use of the more highly developed agricultural countries, another is less extensive, and a third, representing minimum requirements, is intended for the less developed agricultural countries. In this way it is hoped to gather data much more accurate and suitable for making comparisons than have ever before existed. Agricultural progress depends to an important degree on a knowledge of agricultural resources. The world census of agriculture will furnish an inventory of such factors as land areas, crop acreage, harvest yields, the number and kinds of livestock in different countries, the amount of mechanical power and equipment used, and the amount of human labor available for agriculture. It should help farmers everywhere in adjusting their production and marketing more accurately to the demands of the market and should also disclose strong and weak points in agricultural systems.

COOPERATION WITH THE FEDERAL FARM BOARD

As required by the agricultural marketing act of 1929, the department cooperated closely with the Federal Farm Board. The Division of Cooperative Marketing was transferred from the department's Bureau of Agricultural Economics to the Farm Board. Other units of the department assisted the board with research and service. In this way duplication of effort was avoided. The board's agricultural responsibilities do not overlap those of the department, but rather supplement them. The primary duty of the board is to help farmers organize cooperative marketing associations, for the improvement of the distribution of farm products, and to aid in preventing the production of surpluses. An important part of the department's contribution to the work of the board is to furnish accurate economic and other information upon which the board may base its policies. In its efforts to minimize speculation, to prevent inefficient and wasteful distribution, to organize the producers into effective marketing associations, and to bring about a better adjustment between farm production and market needs, the board depends vitally on facts given to it by the department. It looks to the department for basic information on land utilization, credit, insurance, crop, and price conditions, foreign agricultural conditions, and market prospects at home and abroad. The board is assisted by the department's extension forces in campaigns for organization among farmers and for a better adjustment of crop acreages. This phase of the department's cooperative relations with the Federal Farm Board will be referred to again in connection with the department's extension and information work generally.

EXTENSION WORK

Cooperative extension work took a strong economic turn during the year. As a result, marked progress was made in the effort to reorganize farming so as to place equal emphasis on effective indi-

vidual practice and on wise group action tending to regulate production and the movement of commodities into consuming channels. Facts presented by extension agents bearing on production and marketing and on the economic situation met with intelligent response from farmers and had a constructive influence in changing farm practices. A vigorous effort was made to acquaint farmers with the objects, relations, and business possibilities of cooperative associations and with the requirements for membership. The assistance of extension agents in organizing over 1,000 local cooperative marketing associations in 1929 indicates the practical support the Extension Service gave the Federal Farm Board in the administration of the agricultural marketing act.

Helping Farmers Look Ahead

Extension agents helped farmers to look ahead. They combined general economic information furnished by the Bureau of Agricultural Economics with local data gathered by State agencies. Facts on the needs of particular localities, and even on the needs of particular farms, were applied in farm-management recommendations. By bringing about a substantial adoption of those recommendations, extension agents made progress in aiding farmers to establish a good balance among different crop enterprises and to adjust production to market requirements. In these efforts to meet the economic situation by adjustment of production, extension agents cooperated in the campaigns conducted by the Federal Farm Board in the Cotton Belt and in the spring and winter wheat areas.

Technical and economic facts were presented at hundreds of farmers' meetings. Recommendations made in the department's periodical outlook report were more widely and painstakingly disseminated than ever before. Market conditions were analyzed in an effort to foresee the probable effects of failure to readjust farm production. Certain crop enterprises, particularly tobacco and potato growing, were brought into a better relationship with the markets as a result of extension work done in farm management and economics. An effective organization—the Interstate Early-Potato Committee—was sponsored by the extension divisions of Maryland, Virginia, North Carolina, South Carolina, and Florida. Its representation included growers' associations, shippers, and others interested in the early-potato market.

Credit Facilities Improved

Farm-credit facilities were improved in some regions through extension work. Agents helped farmers in taking annual inventories and in making out credit statements for their banks. This work was done in a greater number of States than ever before. It resulted in a measurable shifting of expensive short-time merchant credit into much cheaper and more efficient bank credit. More than 25,000 farmers cooperated with extension agents in keeping detailed accounts which were useful, not only for credit purposes, but as a guide in farm management. Twenty thousand farmers cooperated in keeping cost-of-production records. These records showed the strong and the weak spots in farm business and helped to raise the average stand-

ard of farm practices by focusing attention on the practice of the more successful farmers. In many counties in all parts of the country, county agricultural programs were developed on the basis of census figures and other data.

4-H Clubs

Boys' and girls' 4-H clubs made an exceptional showing during the year. The total enrollment in these clubs was 758,096. Sixty-seven per cent of this membership satisfactorily completed the work prescribed in agriculture and home-making. The showing was considerably better than that of the previous year. It was, in part, a result of the use of increased funds made available by the Capper-Ketcham Act of 1928. Credit is due, also, to a quickened interest manifested in the club movement, not only by farm people but by other groups. Many national organizations cooperated with the department and with the State agricultural colleges in drawing attention to the value of the clubs and in building up their membership. Club members reported giving 994,262 demonstrations of improved farm and home practices, or more than 51 per cent of all the demonstrations of that character that were made through extension channels during the year. Taking the country as a whole, county agricultural agents and home demonstration agents devoted about a third of their time to 4-H club work. Federal, State, and county funds supported the club work. It gives boys a practical training in plant and animal production and girls an equally practical training in gardening, poultry raising, cooking, dietetics, and home-making.

The talking picture made its advent in the field of mediums used in extension teaching, such as publications, news stories, lantern slides, charts, and exhibits. A drop in the demand for silent films used by extension agents naturally resulted. Nevertheless, the call for the department's motion pictures continued to exceed the available supply. More than 3,500,000 persons attended showings of loaned department pictures, and 3,368 film shipments were made during the year. The attendance at showings of the department's films was, however, less than in the preceding year. This seemed to be a result of "talkie" competition, and the department accordingly made experiments in sound-recording projects. It purchased a disk sound-projecting apparatus and provided a synchronized accompaniment for two existing pictures. As soon as facilities are available, production will be started by the department on sound pictures.

Growth in Personnel

Cooperative-extension forces grew during the year. County agents, who numbered 2,580 throughout the country on June 30 last, were aided by 854 full-time and 246 part-time subject-matter specialists attached to the State agricultural colleges. The extension service also included 1,225 county home-demonstration agents, 246 county club agents, and 303 negro extension agents. There were 414 supervisors and assistant supervisors and 74 administrative officers and assistants. This was an increase for the year of 184 county workers, 4 administrative and supervisory workers, and 63 subject-matter specialists. Approximately 4,800 of the extension workers were cooper-

ative employees of the department. Increased funds became available under the Capper-Ketcham Act of May 22, 1928, which made immediately available to each State an additional \$20,000 for cooperative extension work. In 1929 the increase was supplemented by a lump sum of \$500,000, only the latter contribution requiring to be matched with an equal contribution from the States. Nevertheless, State and local appropriations have been increased during the last two years by approximately \$1,500,000. One result was an increase of 317 in the number of home-economics extension workers. On June 30 last the personnel engaged in this work was 1,685, among whom were 1,345 county home-demonstration workers. Farm women participated as local leaders in home-demonstration work in increased numbers.

Funds for Extension Work

The total funds available for cooperative extension work from all sources during the fiscal year were \$24,257,800, an increase of nearly \$1,340,000 over those for the previous year. Approximately \$274,000 of this increase was in Federal funds and \$1,066,000 in State and county funds. Of the total funds, 38.1 per cent, or \$9,251,760, was contributed by the Federal Government, exclusive of the privilege of using penalty envelopes; and 28.6 per cent, or \$6,948,450, was from State appropriations to the agricultural colleges and other State agencies. The remaining 33.3 per cent, or \$8,057,590, came from county appropriations for extension work and from contributions by local organizations and individuals. About 95.4 per cent of all funds used for cooperative extension work in 1930 came from public sources.

INFORMATIONAL WORK

By distributing approximately 25,000,000 popular and technical publications; by giving press associations, syndicates, newspapers, and magazines some 3,000 news and interpretive articles; by cooperating with editors, special writers, and correspondents; by furnishing speakers and manuscripts daily to over 300 radio stations in all parts of the country; by having officials give hundreds of addresses, including lectures in colleges; and by writing several million letters the department made its information available during the fiscal year 1930. The purpose of these activities was not to gain publicity for the department, but to make known facts that farmers and home makers can use to improve their practices.

Economic Information Used Extensively

Popular, as distinguished from technical, publications were in such demand that only 60 per cent of the requests received from farmers could be met. A large percentage were requests for economic information, such as data on prices, probable future demand, acreage adjustments, and farm management. This showed that farmers were becoming economic minded. The demand for information on plant production and animal breeding increased also. The economic and scientific services of the department and State agencies are so correlated that farmers can readily secure information concerning all their farming operations.

Gathering and distributing facts to help farmers make adjustments to meet changing conditions in production and marketing is a major function of the department. Facts on trends of production and demand must be used as a guide in planting and livestock breeding. The agricultural-outlook service has now been extended into every State and covers over 40 crops and classes of livestock. This year's outlook report, presenting facts on production and demand and indicating the probable market for the season's crops, was not only brought directly to more than 200,000 farmers at 4,200 group meetings, but was also used in one special and many follow-up radio programs which carried the information quickly to several million farmers; furthermore, special publications were issued on this subject, and the press helped extensively. The market-news service was extended to several States in the South and Northwest which had not previously been served with daily market reports. The crop-reporting service was expanded to cover fruit, truck, and canning crops. These are only parts of a growing economic-information service which is more widespread and detailed than any other ever established by a government.

Special Informational Campaigns

Unusual developments in the agricultural situation and in Federal help to agriculture called for special informational campaigns. For example, the weakness in cotton prices prompted a vigorous educational campaign by information and extension forces to influence southern planters to grow cotton on profitable acres, and to set aside as much of the land ordinarily devoted to cotton as would be necessary to provide food for the farm family and feed for livestock. A similar campaign was carried on to encourage a reduction of the wheat acreage and the growing of crops for which a better market was anticipated. The Federal Farm Board's efforts to encourage and strengthen cooperation among farmers, the drought situation, and the fight against the Mediterranean fruit fly in Florida also necessitated intensive informational work.

A rapid expansion took place in the department's radio work at practically no additional cost to the Government. For enlarged chain broadcasts, giving the entire country daily economic information, for weather and market news broadcasts, and for general educational programs the department now uses daily more than 50 per cent of the radio stations in the country. Radio time contributed free to the department is worth commercially about \$1,500,000 annually. Plans will soon be completed for a new Pacific coast program, which likewise will cost the department nothing.

In the past it has been the policy of the department to furnish its publications and other information pamphlets free to all who can use them. Necessarily there is a growing restriction on this general principle because of the large cost that would be entailed in satisfying all requests. To offset this somewhat, the Superintendent of Documents is selling more of the department's bulletins. Additional funds appropriated for printing and binding will alleviate the present condition somewhat.

TRADING IN FUTURES

Trading in wheat futures on the grain exchanges designated as "contract" markets under the grain futures act of 1922 amounted, in the year ended June 30, to 19,606,790,000 bushels. This was the largest volume of future trading done in wheat in any of the nine years for which the Grain Futures Administration has records. Wheat futures accounted for 78.4 per cent of all the trading done in grain futures on the United States markets, as compared with a 9-year average of 64.9 per cent. The total for the previous year was 12,195,034,000 bushels. The previous record volume of trading was done in the season 1924-25, when the total was 18,875,965,000 bushels. The smallest volume of trading in wheat futures done in any year covered by the Grain Futures Administration's records was 7,316,910,000 bushels in 1923-24.

The increased activity in wheat futures was not, as is frequently the case, associated with rising but with falling prices. As a group the large speculators operated principally on the short side. Hedging against the country's large stocks of wheat partly accounted for the increased trading. In addition there was large speculative buying by small traders and the general public. Apparently these buyers had hopes of higher prices. The Grain Futures Administration, as in former years, issued daily reports of the trading done and of the total of open commitments in each future at the principal markets. No particularly violent fluctuations in prices were recorded on individual days. Evidence was disclosed, however, of certain practices that led to the filing of charges against three operators on one grain exchange. Cases arising out of these charges are now pending before a commission set up under the grain futures act.

Exchanges Are Necessary

Grain exchanges play a necessary and important part in our marketing system. They afford an easy and rapid method for the expression of the mass opinions of buyers and sellers as to supply and demand relationships. Each hour of the trading day, trading in futures establishes public prices against which producers and consumers can check any offers they receive. Markets for the purchase and sale of commodities for future delivery are necessary for the obvious reason that the total available supply of a commodity can not be delivered at once, nor can it be processed or manufactured immediately it is produced. Millers and dealers use the futures markets much as other merchants use insurance. They cover present transactions in the cash-grain markets with hedging transactions in the futures markets, thereby getting protection against violent price fluctuations. This practice, by lessening speculative hazards, enables the millers and dealers to do their business on a smaller margin of profit than would otherwise be necessary. The same observations apply to the cotton-futures markets. The facilities afforded by these institutions should be retained. At the same time, they should be improved and in some respects fortified with additional safeguards to prevent abuses. Considerable improvement has already been afforded through the administration of the grain futures act; yet more remains to be done.

Trading Practices Should Be Improved

There is the problem, for example, of the deliverable grades. Until recently in Chicago a buyer who desired the delivery of wheat purchased in the futures market might be compelled to accept 17 different grades or a combination of 17 grades at different warehouses, and at prices and bonuses fixed by the exchange. Recent amendments to its rules by the Chicago Board of Trade have reduced the deliverable grades to nine, thus strengthening the contract from the buyer's standpoint.

The rules of cotton and grain exchanges are not, at present, subject to review by any agency in the interest of the producers or the consumers. It would seem to be in the public interest to change this condition.

Contract-market rules covering the execution of futures orders should be amended to give customers and traders assurance that their purchases and sales will be handled by brokers who are not themselves interested in the market. Under present conditions, brokers have an opportunity to take customers' orders to their own accounts, at prices advantageous to themselves. This is wrong. Another practice that should be stopped is cross trading whereby operators buy and sell the same quantity of grain in the same future at the same price, with exactly offsetting results. This practice affords a means of registering fictitious quotations, and of concealing the brokers' personal interest in orders handled for customers.

Grain exchanges have cooperated in the enforcement of the act and in the elimination of abuses. As I have already said, much improvement has been made. The nature of future trading and the intricate machinery necessary to conduct it on a large scale make supervision necessary and desirable. Existing legislation does not give the Federal Government any authority to limit excessively large speculative trading, or to limit short selling calculated to demoralize prices.

PLANT QUARANTINES

Efforts to eradicate the Mediterranean fruit fly have been far more successful than was expected at the beginning of the eradication campaign. While total eradication can not yet be announced, there is strong hope of it. Up to July, 1930, no adult fly had been found in Florida since August 27, 1929; and only two larval infestations (one on November 16, 1929, and one on March 4, 1930) had been found subsequent to that date. In the November infestation, 4 larvae were found in one orange in a grove near Orlando, Fla. In the March case, 10 larvae were found in two sour oranges in a grove in Orlando. The most recent infestation discovered consisted of 2 living fruit fly larvae in a dooryard at St. Augustine, Fla., on July 25, 1930.

The minor nature of these infestations, together with the results of the intensive field inspection indicate that the eradication work performed in Florida has been so successful as to justify the removal of many of the more stringent quarantine conditions previously enforced. An order approved August 9, 1930, materially modified the restrictions governing the movement of Florida fruits and vege-

tables. One change made it unnecessary thereafter to sterilize Florida fruits and vegetables for shipment to the Middle Western States, except in the case of products grown on properties close to recent infestations or where growers had failed to comply with clean-up, spraying, and similar requirements. On shipments to the Southern and Western States, where the fruit fly if established would be especially injurious, the sterilization requirements except in the case of limes were continued in force. Shipments to that region, however, were permitted throughout the shipping season instead of being restricted to the mid-winter months as was done in the winter 1929-30. It was decided to allow the shipment of Florida fruit throughout the entire United States up to June 15, 1931, except in the event of the discovery of new serious outbreaks of the fly. Restrictions on vegetable shipments were modified, and the so-called infested areas, in which special safeguards are required, were reduced in size. Reshipment restrictions from the Northeastern States to the Middle West were removed. The only restrictions retained in force concerned the movement of Florida host fruit and peppers from points north of the southern line of Virginia, Kentucky, Missouri, Kansas, and Colorado to the 18 Southern and Western States. This movement, as in 1929, was prohibited.

Spread of Fruit Fly Prevented

There is no doubt that the prompt action taken by the department in 1929, in cooperation with the State authorities of Florida, prevented widespread infestations of this extremely destructive pest. The saving thus effected in eradication and control work is incalculable. From March 27 to June 13, 1930, lack of funds necessitated the suspension of field-inspection work. On the latter date, however, inspection was resumed. In January last a Federal fruit-fly board was appointed, consisting of five leading entomologists—W. C. O'Kane, State entomologist of New Hampshire and chairman of the board; George A. Dean, professor of entomology, Kansas State Agricultural College; W. P. Flint; State entomologist of Illinois; P. J. Parrott, entomologist of the New York Experiment Station; and J. J. Davis, professor of entomology at Purdue University. This board studied the problem in Florida, put eradication policies into effect, and supervised the expenditure of Federal funds. It recommended a number of the changes already reported in the fruit-fly quarantine districts.

Quarantine restrictions against the Mediterranean fruit fly mean unavoidable expense to growers, shippers, and others. It is worth noting, however, that the restrictions in 1929 permitted the marketing of Florida's fruits and vegetables in almost a normal manner, though fly infestation was then very heavy. Quarantines are generally considered as tending to throttle business. In the case of the Mediterranean fruit-fly quarantine, Federal certification made the country's markets largely open to Florida's products. The Federal quarantine legally inhibited State quarantines and thus kept open many markets that might otherwise have been closed.

Japanese-Beetle Quarantine

The quarantine enforced to check the spread of the Japanese beetle was of similar advantage. Under this quarantine plants and plant products are certified for shipment after they have been inspected and, in some cases, treated. Certificates thus issued guarantee the acceptance of the certified plant by inspection officials in the States to which the shipments are sent. In the fiscal year 1930 Federal certification authorized the movement of 97,788,480 plants out of the area quarantined on account of the Japanese beetle; also many thousands of boxes of cut flowers and thousands of carloads of sand, soil, and earth were certified for shipment. The Japanese beetle spread during the year at its normal rate and was discovered at several points some little distance from the quarantined area. These points were quickly subjected to control with respect to the movement therefrom of susceptible products.

Pink Bollworm of Cotton

An outstanding development of insect infestation in 1929 was the outbreak of the pink bollworm of cotton in a large area of the Salt River Valley in Arizona. This area specializes in the growing of Pima or long-staple cotton. The department, in cooperation with the State commission of agriculture and horticulture, began eradication measures. Two noncotton zones were established, and a field clean-up of some 47,000 acres of cotton was made, with funds specially appropriated for the emergency. The undertaking promises to be successful. Congress also appropriated funds to enable the Federal Government to compensate growers in the affected area for one-half of the actual and necessary loss resulting to them from ceasing to grow cotton. The other half of the loss will be paid by the State of Arizona.

Mexican Fruit Fly

The Mexican fruit fly reappeared in the Rio Grande Valley in the last fiscal year, but was promptly exterminated. It first appeared there in 1927. The department is cooperating with the Mexican Government in measures to reduce the infestation in near-by areas on the Mexican side of the Rio Grande. Inspection and clean-up work is also in progress in the citrus areas of the Rio Grande Valley in Texas.

CONTROL OF INSECT PESTS

New means for controlling insect pests developed from the research in the Bureau of Entomology. Particularly successful work was done in the improvement of poison bait for the Mediterranean fruit fly and in the treatment of fruit to prevent its being a means of spreading the insect. A safe and effective bait spray for the fruit fly is now in general use in the originally infested area of Florida. It substitutes a copper carbonate solution for the lead arsenate solution used at first, which was believed to diminish the acid content of

the fruit and make it more or less insipid. Extensive use, besides demonstrating the safety and effectiveness of the new spray, indicated that it may be valuable also against other insects. This discovery was a striking advance in pest control. It was made in a search of the entire group of available poisons for a bait spray at once harmless to citrus plants and toxic to the fly.

In treating fruit to make it safe for handling, shipment, and sale, the bureau improved both the heat process and the cold process that it developed in 1929. These methods permitted the successful and profitable handling of Florida's citrus crop and proved valuable in the handling and storing of fruits and vegetables for other reasons than the necessity of controlling the Mediterranean fruit fly. The heat treatment was used widely for the immediate handling and sale of fruit. The cold treatment, as modified on the basis of experiments made in Hawaii, permitted the successful storing of fruit for later sale and distribution. It calls for a temperature of from 30° to 31° F. continued for 15 days. This temperature practically eliminates risk of freezing the fruit and is well within the range of the standard equipment used in cold-storage plants. It is easily maintained in ordinary storage practice. In experiments in Hawaii, the modified treatment was always fatal to both eggs and the larvae of the fly.

Aid to Peach Growers

Insect-control measures advocated by the bureau helped peach growers this year to market a crop much better in quality than the crop of 1929, when insects caused heavy damage. Two species, the plum curculio and the recently introduced oriental fruit moth, were the chief causes of the 1929 loss, which was widespread east of the Mississippi Valley, particularly in the South. Though much fruit was discarded in the orchards, a considerable amount reached the market in a wormy condition. Consumers lost confidence in the quality of peaches in general, and prices suffered. This year the bureau carried on an intensive campaign to impress upon growers the necessity for insect control. It especially emphasized the importance of fighting the plum curculio. State entomologists and extension workers cooperated. Growers paid special attention to spraying and dusting, destroying infested fruit, and other means of control. These measures with the added advantage of favorable weather brought gratifying results.

Protective Treatment for Stored Grain

Better protection of stored grain from insects is now possible by a new fumigation method developed during the year. This was the outcome of cooperative work between this department (through the Bureau of Entomology and the Bureau of Chemistry and Soils) and the Bureau of Mines. It requires the use of the fumigant, ethylene oxide-carbon dioxide mixture. So efficient and easy to use is the new method that it promises to replace all other means of protecting grains stored in bulk. In tests made with the cooperation of the New York Produce Exchange, in which several million bushels of wheat were treated, the ethylene oxide-carbon dioxide mixture proved highly toxic to grain insects and practically free from the fire

hazard that attended the use of certain of the older methods. Outstanding importance attaches to this discovery of a new and safe insecticide for grain insects, which cause heavy damage to stored grain and cereal products, particularly in the South.

Insect Damage to Livestock Reduced

Losses caused by insect damage to livestock have been reduced during the year in the Southwestern States. The screw worm is a destructive pest of cattle, sheep, and goats. Screw-worm damage has been much reduced by a system of prevention and control which involves the prompt destruction of carcasses in which the fly may breed; dehorning and other measures to reduce the number of wounds that afford entrance for the pest into live cattle; the control of breeding so that calves, lambs, and kids will be born out of the screw-worm season; location of "hospital pastures" on high ground; the use of fly cages to protect valuable injured animals; the use of fly traps; and the use of benzol and pine-tar oil in treating screw-worm cases.

The department in cooperation with the Texas experiment station developed a new dip for the destruction of the lice that attack the Angora goat. This treatment, which is cheap and effective, is the dipping of goats in a suspension of very fine sulphur and water, which kills all the lice and their eggs in one operation without injuring the goats or their hair. It promises to be of great value to the Angora-goat industry.

Pine-Tip Moth Controlled by Parasite

A striking result last year in forest-insect work was the control of the pine tip moth at the extensive plantations of the Forest Service at Halsey, Nebr. For 20 years the pine tip moth has seriously retarded the growth of young pines at Halsey until, in 1925, the Bureau of Entomology introduced into the Halsey area an insect parasite of the tip moth from Virginia. This year the degree of parasitism existing near the point where the parasite was originally released amounted to about 82 per cent, and the number of pine trees infested by the pine tip moth had dropped from 90 per cent to 33 per cent. Permanent self-sustained control with little expense seems probable.

European Corn Borer

The European corn borer did not spread normally this year in Pennsylvania, Ohio, Indiana, and Michigan. Its increase was checked by heat and drought. A large percentage of the eggs, which are laid on the underside of leaves, were killed when the leaves curled and exposed the eggs to the sun. The mortality was heavy in the larvae also. As a result, there was practically no westward spread of the insect. There was a little spread to the south—in West Virginia, Ohio, and Indiana. Practically no commercial damage was done in the western area. In New England, in the so-called 2-generation area, the borer increased somewhat. More infestation in vegetables and weeds as well as in corn was observed.

Introduction of the corn borer's natural enemies into the United States promises to be an important controlling influence. This season up to July nearly 650,000 imported parasites, representing 17 different species, were released. It appeared, from the recovery of parasites from previous liberations, that at least 11 species had been successfully established. In some cases colonies of the parasitic insects had become so strong that collections could be made therefrom for shipment to other areas. Whether the corn borer will prove a serious menace to the main Corn Belt is still undetermined.

Other Serious Pests

Serious damage was done this year by the range caterpillar to the valuable blue grama grass on cattle ranches in northern New Mexico and in the Texas Panhandle. This insect has barbed spines that are extremely irritating and poisonous both to range animals and to man. It causes loss of forage in addition to the grass it actually consumes because cattle will not eat where the caterpillar has crawled or fed, since it leaves behind it webs in which are incorporated its poisonous shed skins and spines. About 15 years ago an outbreak of the range caterpillar was brought under control by the natural increase of an egg parasite of the pest. The Bureau of Entomology is attempting to speed up the increase of this parasite so that control of the caterpillar, which would tend to come about under natural conditions in six or eight years, may be brought about in three or four.

In northwestern Colorado a serious outbreak of the Mormon cricket was brought under control, through cooperative work with the State of Colorado in control campaigns. Only outlying districts distant from cultivated areas remain to be cleaned up. Final clean-up work, though extremely difficult because of the nature of the country, is essential as a safeguard against future outbreaks.

The Mexican bean beetle, which was not known in the Eastern States until 1920, now inhabits most of the United States east of the Mississippi River. It has caused heavy damage to beans. Indications are that it has now reached its northern limit of destructive abundance. General remedies such as plowing under the bean crop and planting bush rather than pole beans are valuable. Insecticides, such as magnesium arsenate and pyrethrum, give satisfactory control of the insect.

The European earwig, which was introduced many years ago simultaneously on both Pacific and Atlantic coasts, probably will spread more or less widely and prove an important addition to the list of introduced pests. It is not destructive to important crops, though it harms garden plants and the succulent ornamentals. It is chiefly obnoxious in houses in which it swarms. The Bureau of Entomology has developed a bait for the earwig which is satisfactory under dry conditions and where gardens are not artificially watered.

RESEARCH IN CHEMISTRY AND SOILS

In a definite program to diminish soil erosion, which involves annually a loss of more than 500,000,000 tons of soil in the United States, the Bureau of Chemistry and Soils last year set up six experi-

ment stations for the study of the problem. These are in Oklahoma, Kansas, Missouri, Texas, and North Carolina. Erosion under different soil conditions will be studied at these stations. The Oklahoma station is intended to serve the red-plains region, which comprises more than 36,000,000 acres. Erosive soils, comprising about 6,000,000 acres, are the subject of study at the Kansas station. The station in Missouri will serve a region in Iowa and Missouri comprising about 6,000,000 acres. One Texas station is located in a sandy region; another serves the rich black belt of that State. The work there will cover a large area of similar neighboring lands in Arkansas and Louisiana. The station in North Carolina will study the southern piedmont soils, comprising some 30,000,000 acres. More than 60 per cent of this area has been damaged by erosion, some of it irreparably.

Important facts have been learned already. In the rich black belt of Texas, for example, the white chalky subsoil absorbs water much faster than the black topsoil. This makes the subsoil less erosive. The demonstration of this fact has an important bearing on agriculture and also on highway building. In Oklahoma experiments in the protection of eroding fields by terracing have stimulated wide interest. Farmers are applying the demonstrated methods on their own farms. Terraces of various types are being built and tested at all the soil-erosion stations. Cropping schemes are being studied to show their relationship to erosion control.

Fertilizers Increase Sugar-Beet Yields

Soil-fertility experiments have produced significant results in the last year. In 7 of the 18 States where sugar beets are widely grown, it was demonstrated that the proper use of fertilizer would increase the yields by an average of 3 tons an acre. Fertilizers high in phosphoric acid produced the largest increases. It was shown that sugar-beet lands can be fertilized at from \$2 to \$2.50 an acre. An increase of 3 tons an acre in the yield means a gross profit of about \$18 above the cost of the fertilizer. The acreage fertilized this season was estimated at from 200,000 to 250,000 acres. Should the yield be increased by 3 tons an acre as a result of the fertilizing, the value of the crop would be increased by \$5,000,000, less \$500,000 spent for fertilizer.

In the Southeastern States the bureau has demonstrated that small applications of manganese sulphate and other heavy metals on non-acid soils will make these soils yield profitable truck crops. When these soils are not so treated, many crops thereon fail. Similar soil treatment has proved useful in the truck sections of North Carolina and South Carolina, particularly with strawberries. The gain to the growers from the discovery that their soils may be improved by manganese sulphate is substantial.

Soil Surveys Cover 800,000,000 Acres

More than 21,500,000 acres in counties representing every important farming region of the country were mapped by the soil survey in the last fiscal year. This work brought the total area surveyed and described to more than 800,000,000 acres. It will be necessary eventually to classify the lands of the United States according to their

natural productivity and adaptation to different crops. In this task the information gathered by the soil survey will be indispensable. Heretofore the expenses of the soil survey, both Federal and State, have been only slightly more than 2 cents an acre. For this small expenditure the Nation has an inventory of its soil resources which in accuracy, scope, and practical value is acknowledged to surpass anything in existence elsewhere. The surveys show what soils are the most productive and give the exact location and the extent of the different soils in each county surveyed. They show how soils may be selected in the order of their natural productivity. Special value attaches to this work at the present time because of the readjustments that are taking place in American agriculture.

Chemistry Aids Cotton Industry

The Bureau of Chemistry and Soils developed this year an entirely new series of vat-dye intermediates from diphenyl and phthalic anhydride. These are expected to be of great value to the cotton-textile industry and therefore to the growers of cotton. In 1929 the consumption of domestic vat dyes in the United States exceeded 9,000,000 pounds, as compared with 6,500,000 pounds in 1928. The new dye intermediates produced by the department's chemists will, it is expected, be a further help in meeting the competition of foreign vat dyes. The domestic vat-dye industry is based on the department's synthesis of phthalic anhydride. The new products will lead to the production of fast dyes that should materially widen the market for cotton goods.

The bureau demonstrated during the year that cottonseed meal, commonly used as a cattle feed, may become valuable in human nutrition. It is rich in and by far the cheapest source of the antipellagra vitamin G. It is also an important carrier of the antineuritic vitamin B. Yeast is considered the richest natural source of these two vitamins, but commercial cottonseed meal is the only substance that even approximates yeast as a source of both of these vitamins. Yeast is used in treating pellagra, but it is costly. Commercial cottonseed meal is not suitable for human consumption. Experiments are under way, however, which may overcome this difficulty.

Fish Oils a Valuable Source of Vitamins

The Bureau of Chemistry and Soils, in cooperation with the Bureau of Fisheries, Department of Commerce, recently demonstrated that fish oils containing vitamin D are available in immense quantities and can be used profitably in animal feeding. These oils can be obtained at about a third to a fourth of the present cost of cod-liver oil, which is widely used in livestock feeds. In fact, vitamin D is considered essential for the raising of chicks and other young animals. California produces annually about 4,000,000 gallons of pilchard oil, which is as rich as cod-liver oil in vitamin D. Tuna oil, equally rich in this vitamin, is produced in smaller quantities. Salmon oil, which is very abundant, is about half as rich in vitamin D as cod-liver oil. It ranks with the poorer grades of cod-liver oil in vitamin A content. The price paid for vitamins A and D in salmon oil is lower than the price paid for the same vitamins in

cod-liver oil. It seems possible, moreover, to improve the vitamin A content of salmon oil by better manufacturing processes. The supply of salmon oil can be increased fivefold or sixfold. At present millions of pounds of salmon offal are dumped into the waters of Alaska every year.

Pine-gum Filter Improves Rosin

The Bureau of Chemistry and Soils has developed a new type of filter for cleaning crude yellow-pine gum. This filter cleans the gum so completely that the resultant rosin is as transparent as ordinary colored glass. It is the first practical means of cleaning crude gum without diluting it with rosin solvents. The process will probably add a dollar to the value of every barrel of rosin filtered by it. Its general use would add half a million dollars to the value of the South's annual production of rosin. Rosin made by the new process should be in keen demand by manufacturers of varnishes and paper size.

Cheaper Potash Indicated

Cheaper potash for American farmers seems possible in the near future. The department has recently demonstrated that the volatilization of potash from leucite is feasible by smelting with special reagents and that the potash can subsequently be recovered in concentrated form. This can be done to special advantage simultaneously with the volatilization of phosphoric acid. The materials thus obtained can be combined to form potassium phosphate, a highly concentrated fertilizer salt.

Enormous deposits of leucite exist in Wyoming, along with plentiful supplies of high-grade phosphate rock and cheap fuels. The utilization of these resources in the production of potash by the method newly discovered, or by improvements thereof, seems entirely practicable. In fact, our annual production of potash salts has increased rapidly in recent years and now totals more than 100,000 tons. Nevertheless this country still depends largely on foreign potash. This is unsatisfactory not only because it involves high transportation costs but because our increasing use of concentrated fertilizers demands large quantities of high-grade potassium salts. The department's recent discoveries will no doubt help in the expansion of the American potash industry.

Besides studying the properties of the leucitic rock of Wyoming, the department is studying the alunite of Utah, the potash shales of Georgia, and the greensand of New Jersey. Alunite has a promising future as a raw material for potash and alumina. Heretofore the processes employed in extracting these products have not been economical. The alumina recovered has not been pure enough nor abundant enough to give it a satisfactory market position. The department is developing improved extraction methods that are expected to permit the use of lower-grade alunite than that formerly required. This will increase the latent potash resources of the raw material. Investigations made at the request of the Bureau of Mines on the ammonium carbonate-ammonia extraction of polyhalite (a Texas saline material) indicate the commercial possibility

of effecting a practically complete separation of the potash from the associated calcium and magnesium compounds. It appears practicable, also, to make an additional saving at the same time through the formation of ammonium sulphate from sulphuric acid of the polyhalite and the ammonia in the leaching solution. In these concentrated forms the fertilizer salts can be transported at a greatly reduced cost. In acid-extraction experiments with the greensands of New Jersey, iron and aluminum salts and adsorptive silica (glaucosil) have been obtained as valuable by-products.

Rotenone Tested Against Destructive Pests

Research is under way to develop a synthetic process for producing rotenone, a promising substitute for lead arsenate as an insecticide. Chemists in the department recently extracted rotenone from Derris root for the first time in the United States. This poison is highly toxic to many insects, yet it is as harmless to plants and to warm-blooded animals as any insecticide that has yet been discovered. In recent tests as a stomach poison it proved thirty times as toxic to the silkworm as lead arsenate. Rotenone is being tested against the codling moth, the European corn borer, the Mexican bean beetle, aphids, and other destructive insects. The department's chemists believe it will be harmless to man if eaten in the form of a spray residue on fruit. This quality should give rotenone, if it can be produced cheaply in commercial quantities, an advantage over lead arsenate, the poisonous residue of which is difficult to remove from apples and pears. The present cost of rotenone, from \$10 to \$20 a pound, prohibits its use by the average farmer or fruit grower. There is hope of producing it artificially or by developing a similar chemical product. The sole present source of rotenone is Derris root (*Derris elliptica*), which is obtained in the East Indies.

Fire Hazards From Moving Belts Preventable

Means of preventing the serious fire losses often caused by static electricity in moving belts in factories have been developed by the Bureau of Chemistry and Soils. How serious the fire hazard is may be judged from the fact that in some cases 25,000 to 50,000 volts were detected between pulleys, though the shafts and pulleys were well grounded. The bureau has demonstrated that belts can be made to conduct electrical charges to the pulleys from which the charges can be grounded harmlessly. This is done by weaving wires into the belts. Accumulating static charges are carried through these wires and grounded without the risk of ignition which would otherwise be present. It is also possible to prevent electrical discharges on moving belts by treating the belts with dressings that have conducting properties. This treatment causes the static charges to pass over the surface of the belts to the grounded pulleys.

Nitrogen Fixation

Research by the fixed-nitrogen laboratory of the Bureau of Chemistry and Soils is reflected in the progress of the fixed-nitrogen industry of the United States, whose output in 1929 was more than

three times that of the preceding year. Its production this year is expected to show a substantial increase over that of 1929. The research laboratory has made a number of important discoveries that have been put into commercial practice. An ammonia catalyst was discovered. Published results of studies undertaken to ascertain the essential properties of nitrogen, hydrogen, and ammonia have profoundly influenced commercial practice. Improved catalytic materials are being developed. The bureau's contribution to air-nitrogen fixation in the United States is not measurable solely in research results, but includes also a contribution of personnel to the industry. Many scientists who began their studies of the problem in the Government laboratory are now leaders in the commercial field. The Government began the study of air-nitrogen fixation about 15 years ago. Progress is now rapid in both research and practice.

Output of inorganic nitrogen by the air-fixation process in the United States was 84,000 tons in 1929, as compared with 26,000 tons in 1928 and 5,900 tons in 1923. These figures may be usefully compared with the output of by-product nitrogen, which was 187,600 tons in 1929, 170,000 tons in 1928, and 123,500 tons in 1923. Our supply of inorganic nitrogen is obtained from three sources—imports, the by-product process, and air fixation. The foregoing figures show the rapid relative advance of air fixation. Domestic production in 1926 furnished 60.5 per cent of our supply of inorganic nitrogen, as compared with 49.5 per cent in 1923.

The first successful direct synthetic-ammonia plant in the United States began production in 1921. Seven others have since gone into operation, one of them this year. The largest has an annual capacity of 108,000 tons of ammonia and the second largest an annual capacity of 54,000 tons. These two plants will be enlarged. Another is under construction. The largest makes sodium nitrate, which competes directly with Chilean sodium nitrate for use as fertilizer. Liquid ammonia is shipped from the fixation plants to the fertilizer factories, to be added to superphosphate. This practice, which is now general, is a distinct economy. Prior to 1929 practically all the ammonia produced by the direct synthetic-ammonia plants of the United States was used for other than agricultural purposes. The output of the new facilities which will come into operation soon must be marketed as fertilizer, as well as part of the output of the existing plants. Linked with the bureau's work on nitrogen fixation are studies of potash and phosphoric acid. A fuel-fired blast furnace is used on experiments in the volatilization of both potash and phosphoric acid. Farmers in the United States spend about \$250,000,000 annually for fertilizer, for which outlay the progress of air-nitrogen fixation promises a much increased return.

PLANT INDUSTRY ACHIEVEMENTS

Plant types and varieties much better adapted to their environment than those now grown will eventually be developed, experiments by the Bureau of Plant Industry definitely indicate. The development and use of crop varieties specially adapted to given conditions play an increasing part in the growing efficiency of American agriculture. The bureau, in cooperation with the State experi-

ment stations, is now applying recent genetic discoveries to many crops on a scale not previously attempted. This plant-breeding work covers practically the entire range of food, forage, and fiber crops, including fruits and vegetables and ornamental plants.

In the northern Plains region the new wheat varieties, Reliance and Ceres, proved distinctly more satisfactory than other varieties grown there. Under favorable conditions, particularly under irrigation, Reliance wheat gave a high yield though it was not resistant to black-stem rust. Ceres wheat showed some resistance to black-stem rust and proved more widely adaptable than any other variety of hard red spring wheat. Both these varieties produce a kernel of good commercial quality. In the quality of disease resistance the best variety yet developed is called Hope. This wheat seems to be practically immune to rust, bunt, and loose smut. Its commercial production is beginning.

A new variety, Tenmarq, in the central Plains region has shown itself more winter-hardy than the Blackhull variety. Oro wheat, a variety developed by the bureau in cooperation with the Oregon experiment station, has proved high yielding and also highly resistant to smut. It has yielded well in Kansas, Nebraska, and Montana. Cooperative experiments with soft red winter wheats, at the Cornell experiment station, have produced from red-kerneled selections an average of 7.5 bushels an acre more than the yield produced by an equal number of white-kerneled selections. Forward wheat, an improved red-kerneled variety developed in these experiments, is being more widely planted. Nevertheless the red varieties are still less grown than the white wheats in New York State.

Stem Rust of Wheat

A discovery of great importance in combating stem rust of wheat has been made in studies conducted cooperatively with the Minnesota Agricultural Experiment Station. Stem rust is the most serious wheat disease in the United States. The infection enters through the open stomata, or breathing pores of the plant. In the resistant varieties it was discovered these stomata remain closed in the morning until after the dew, in which the fungus spores germinate, has dried; hence the fungus spores have no opportunity to infect the wheat. This clue to one cause of rust resistance in wheat is expected to have important practical consequences.

Resistance of Corn to Cold

Important factors in the resistance of corn to cold were developed in cooperative studies at the Illinois experiment station. Some strains while maturing are injured by temperatures considerably above freezing. Others are not seriously hurt by temperatures several degrees below freezing. Some of the strains that resist cold well in the ripening stage resist it also in the seedling stage. All strains resist cold better on the more fertile soils. Strains that are resistant to cold tend also to be resistant to stalk-rotting fungi. These strains also produce better yields and better-quality corn. In the seedling stage the cold-resistant strains are less susceptible to the

seedling blights. The practical importance of these facts is obvious. Early fall freezes severe enough to injure corn are often followed by several weeks of favorable weather. The varieties of corn capable of resisting such early freezes and having also several other desirable characteristics should be more widely planted.

Sugar-Beet Seed Commercially Feasible

The commercial feasibility of sugar-beet seed production from overwintered seedlings is shown by harvest records obtained by the bureau, in the Southwestern States, where mild winters permit the safe wintering of small sugar-beet plants in the field. This method is much less expensive than the one commonly employed in which mother beets must be lifted in the fall, carried over the winter in silos or pits, and replanted the following spring. Seed yields from the overwintering method approximate the standard yields in the most favored sugar-beet seed-producing countries. Commercial development of this method of producing sugar-beet seed would help to develop disease-resistant varieties. Our beet seed now comes from Europe. European beet seed, however, has no resistance to the curly-top disease, which is indigenous to the United States and threatens the sugar-beet industry west of the Rocky Mountains. It has been demonstrated that resistance to curly top can be developed in sugar beets as a varietal characteristic. The demonstration that the home production of sugar-beet seed is possible on a commercial scale by the overwintering method marks an important forward step for the American sugar-beet industry.

Other Developments

From 50 to 75 per cent of the acreage planted to lettuce in the Imperial Valley of California in 1929 was planted to disease-resistant varieties developed in the Bureau of Plant Industry. This year's lettuce acreage in the same region, estimated at 30,000 acres, is about 75 per cent planted to the resistant sorts. These varieties are resistant to mildew and brown blight. They are also more productive than the sorts previously grown.

Notable progress was made in the growing of improved strawberry varieties. The Blakemore, a good dual-purpose variety of excellent flavor, was extensively planted. It was developed at the United States Plant Field Station at Glenndale, Md. About 85,000 strawberry seedlings of known parentage, developed from well-mated crosses, were under observation in Oregon, Montana, and northern California. These studies gave promise of establishing new combinations of color, flavor, size, vigor, and yield.

In a field test near Beaver Dam, Wis., a variety of hemp called Michigan, developed by the bureau for earliness, was harvested and spread for retting 16 days earlier than hemp from unselected commercial seed. This variety was equal in quality and yield to the product of the commercial seed. Another variety developed by the bureau was harvested and spread for retting at the same time as the commercial variety, but yielded 50 per cent more.

Better Cotton Varieties Developed

In recent years many improved varieties of cotton and improved methods of production have been developed, tested, and demonstrated. It is no longer necessary for agricultural reasons to plant varieties producing less than 1-inch staple in any part of the United States. Yet we continue to grow millions of bales of inferior fiber which enters the world market in direct competition with the very short staples of India and China. Fine fabrics are in demand. Larger quantities of strong and uniform fiber are needed in the automobile industry and also in the production of fabrics for airplanes, balloons, and dirigibles. The textile industry in general wants better cotton staples than those generally offered. Here is an opportunity which is not yet sufficiently recognized.

Recent developments in cotton breeding emphasize the fact that in this field agricultural science is far ahead of agricultural practice. A new variety of cotton of real commercial possibilities was developed by crossing Pima, a long-staple variety of Egyptian type, with Sakel, the best of the varieties grown extensively in Egypt. Pima is better than Sakel in type of plant, productivity, size of bolls, and length of lint. Sakel is thought to be better in strength of lint and in spinning value. A combination of the best features of both varieties is obviously very desirable. The Sakel-Pima cross has been grown during 11 successive years. It appears to be quite as uniform as selected strains of Pima and Sakel. Tested in Arizona, it proved in average seasons to be at least as productive as the best strains of Pima. It gave indications that it will outyield Pima in seasons when the first killing frost comes late, since the plants set a very heavy top crop. The new variety has long fruiting branches and bolls that are exceptionally large for an Egyptian type. It gives a consistently higher lint percentage than Pima; moreover it is superior to Pima in abundance of lint on the individual seeds.

Another new cotton variety seems to have distinct resistance to the boll weevil. This is an early maturing type of upland cotton known as the Kekchi. It was selected from cotton discovered in 1902 in Guatemala among the Kekchi Indians. The first plantings in Texas were very abnormal and some were sterile. After several years of acclimatization and breeding, however, normal habits of earliness and productivity reappeared. In several cases Kekchi cotton outyielded all the other varieties commonly grown, and the fiber was of better quality. More important still, the Kekchi variety continued flowering and fruiting after other varieties had ceased to do so on account of weevil attack.

Plant Introductions

The introduction of foreign plants into the United States has been important throughout our history. In fact, our agricultural and horticultural industries, as well as our animal industries, are based on plants and animals introduced from other regions and largely from other continents. This is true not only of the cereals and the grain sorghums, but of corn, potatoes, sweetpotatoes, tomatoes, peanuts, and tobacco. By this time probably most of the foreign crops which can be successfully introduced without change into American agriculture have been introduced. Plant introduction is taking on a

new character. It is directed more to the discovery of important new material for the plant breeder than to the immediate establishment of foreign varieties not hitherto grown here.

Varieties of sugarcane introduced from Java some years ago restored the cane-sugar industry of Louisiana, which had been threatened with extinction by mosaic disease. But the Javanese varieties lack certain desirable qualities. Therefore in 1928 plant explorers for the department obtained as breeding stock more than a hundred primitive varieties and strains of sugarcane from the jungles of New Guinea and Papua. The object is to combine these varieties with types already established in the United States. The entire collection was planted this year in southern Florida and in August was growing satisfactorily. It is planned to make crosses which will combine the vigor of the wild varieties with the high sugar content of the best commercial varieties.

Among the varieties introduced from New Guinea is a species which grows from 25 to 30 feet high, stools prolifically, and is remarkably erect and vigorous. It seems also to be disease resistant. Most of the world's cane sugar now comes from seedlings resulting from crossing a small wild cane (*Saccharum spontaneum*) with cultivated varieties. Since the new wild cane (*S. robustum*) is much larger than *S. spontaneum*, its hybrid progenies should give larger sugar yields. The Bureau of Plant Industry has devised a method whereby a ton of seed cane can be increased sufficiently within two years to plant 1,000 acres. Under the commercial methods in general use only about 30 or 40 acres could be planted under the same conditions. Hence a commercial supply of planting stock can be grown from the new canes in a comparatively short time.

Work With Other Plants

Similar work with other plants promises important results. Alfalfa in the Middle West is threatened with a serious disease called bacterial wilt. Investigators observed that certain alfalfa seed from France and Turkestan produced plants which resisted the disease better than other varieties. Accordingly, seed for testing was obtained in Europe and Turkestan. Samples were brought from every important seed-producing district in the latter country. It is too early as yet to predict the result, but it should give some relief from the bacterial-wilt disease. In the same expedition other seeds of potential value to American agriculture were obtained, including the seeds of numerous grasses, legumes, and melons. Samples of wild and cultivated apricots, pears, and pistachio nuts also were obtained.

In an effort to replace the native American chestnut, now almost destroyed by blight accidentally introduced from Japan and discovered in this country about 25 years ago, the bureau has located blight-resistant strains of the forest type of Asiatic chestnut in Japan and Chosen. It has brought large quantities of seed to this country. This year more than 70,000 trees, representing 162 selected strains of Asiatic chestnuts, were planted in permanent locations. These trees are being tested for blight resistance and other qualities under widely varying conditions. The Asiatic chestnuts have a tannin content in the wood and in the bark equal to that of the American chestnut.

More than 200 lots of soybeans of both wild and commercial strains were recently imported from the Orient. It is believed the collection will extend the areas in which soybeans can be grown in this country and will also increase yields.

Plant-Disease Control

Though some plant diseases may be checked by treating the seed before it is planted, the most destructive diseases, especially those of the fruit and vegetable groups, are more effectively controlled by dusting and spraying. Investigations in the bureau have demonstrated that zinc-lime spray, a recently discovered fungicide, is successful in controlling peach bacterial spot. Large quantities of this material were used by growers this season. Zinc-lime spray may be of value also in controlling peach scab and apple scab.

The campaign against citrus canker is practically won. An infection was found this year in a nursery in Victoria County, Tex., and 5 grapefruit and 15,000 2-year-old *Citrus trifoliata* were destroyed as a control measure. Some scattered infections were found in dooryard plantings in Louisiana. The disease is not known to occur, however, in any region commercially producing citrus fruits. No infections were found during the past year in Florida, Alabama, or Mississippi.

White-pine blister rust is increasing and will undoubtedly reach Maryland, Virginia, and West Virginia within a short time. In the protected pine areas of New England and New York the loss from this destructive disease is less than one-tenth of the losses in unprotected areas. Protection is achieved by eradicating the gooseberry and currant bushes that are the alternate hosts of the disease organism. The bureau is cooperating with the Forest Service and the National Park Service in protecting white pines in the national forests and parks. It is cooperating also with officials and lumbermen in several Western States in a campaign for the eradication of the host plants. Vigorous and prompt action is necessary to avoid heavy loss. The rust recently extended in Oregon to within 50 miles of the Californian border. This is a menace to the forests of southern Oregon and of California. Experiments in local control, however, have indicated that these areas can be protected at a reasonable cost.

In areas where most of the common barberry bushes have been destroyed in the campaign for the control of black stem rust of wheat, local outbreaks of rust have been much reduced. The effectiveness of the barberry-eradication movement is beyond question. It needs, however, to be carried on with unflagging energy.

Eradication of Phony Peach Disease

Complete eradication of the phony disease of peach trees appears practicable, even though it is now known that the disease is not confined entirely to Georgia and Alabama. This season the Bureau of Plant Industry, in cooperation with the States of Georgia and Alabama, began an eradication campaign. It obtained the willing aid of peach growers. Diseased trees were destroyed with great rapidity. Inspectors examined nearly 12,000,000 peach trees during

the season, most of them in Georgia. About 87,000 in Georgia were definitely identified as infected, about 600 trees in Alabama were identified as infected, and about 140 in Mississippi. Many trees were removed on the suspicion that they might be infected. Slight infections were discovered in Louisiana, Arkansas, and Tennessee, and recent inspections located cases of the disease in North Carolina and South Carolina. Accordingly it is planned to extend the eradication campaign to all these States.

PROGRESS IN ANIMAL INDUSTRY

The Bureau of Animal Industry made some notable contributions to the technic of livestock breeding and feeding, and to the control of animal diseases and parasites.

The bureau demonstrated that suitable Wiltshire sides for the English bacon market can be obtained from American breeds of hogs fattened on the commonly grown hog feeds. This means that by the same method farmers can produce hogs for both the foreign and the domestic market. It is simply necessary to select the hogs rigidly for type and to feed them with the market purpose in view. A shipment of hogs was fattened on barley, tankage, and alfalfa pasture at the United States Range Livestock Experiment Station at Miles City, Mont. The hogs were slaughtered and processed in the United States and sold on the Liverpool and London markets. English authorities pronounced the bacon from these hogs equal to the best brands of Canadian bacon.

Recent experiments in sheep raising show that lambs raised on good pasture will produce meat as well finished and as palatable as that from lambs raised on expensive grain feeds. In one experiment a number of lambs that had only pasture brought a slightly higher net return than other lambs that were fed grain while running with their dams on pasture. This result was in accordance with the outcome of similar experiments made in cooperation with Purdue University. Pasture as a feed for lambs is exceptionally valuable both from the standpoint of the return to the grower and from the standpoint of the quality of the meat.

About a third of all the fertile eggs incubated in the United States fail to hatch. The bureau has discovered that the principal causes are hereditary factors, improper nutrition, and faulty conditions of incubation. Experiments with White Leghorns and Barred Plymouth Rocks showed that hatchability decreases as inbreeding increases, and that full brother and sister matings are more detrimental than less intensive breedings. The character of the proteins in the diet of the breeding flocks is extremely important. Tests showed that a diet generous in animal proteins, lime, and cod-liver oil if sunshine is deficient, is necessary, and that a source of pigment, such as yellow corn or green feed, is also required. It is obviously desirable to cull out the hens that lay eggs of low hatchability.

Suppression of Animal Diseases and Parasites

Progress in veterinary science, in the administration of livestock laws and regulations, and in the adoption of control methods brought notable results in the suppression of animal diseases and parasites.

Records of Federal meat inspection showed a marked decline in tuberculosis among cattle and swine. In the fiscal year 1930, though federally inspected slaughter of cattle and swine was more than 1,000,000 head greater than in the previous fiscal year, 10,000 fewer tuberculous carcasses and 40,000 fewer parts of carcasses of cattle, calves, and swine were condemned. Testing to eradicate bovine tuberculosis has been practically completed in nearly a third of the counties of the United States. The tuberculosis-eradication campaign was pushed forward in cooperation with every State in the Union and with several of the insular possessions. In May, 1930, a survey indicated that only 1.7 per cent of the country's cattle were tuberculous, as against 4 per cent in 1922. The number of cattle tested for tuberculosis during the fiscal year exceeded 12,000,000 head. Approximately 217,000 affected animals were slaughtered. Three States, North Carolina, Maine, and Michigan, are now recognized as practically free of bovine tuberculosis, and other States are approaching the same goal. The feasibility of eradicating bovine tuberculosis from large areas as well as from individual herds is thoroughly established.

Fifteen counties in five States were released during the year from the Federal quarantine against the cattle tick. The last remaining counties in Alabama were freed, and that State became the tenth of the 15 originally infested States to emerge from the quarantine. Mississippi was entirely released from the quarantine on July 1, 1930. The tick-infested area of the United States is now only about 20 per cent of its original size. In many localities where the tick quarantine has been lifted purebred cattle have been rapidly introduced. Purebred bulls are now fairly numerous in many sections of the South where only tick-infested scrub sires were previously known.

Infectious abortion continued to take heavy toll of the cattle industry and also of the swine industry. Research has not yet developed a fully satisfactory means of coping with the disease. It has recently developed the important fact, however, that the eye may be a frequent channel of infection. Experiments also indicated that the infection may gain entry to the animal through the skin, even though there may be no visible abrasion.

Complete success terminated a campaign begun two years ago in California for the control of liver flukes of cattle and sheep. This pest formerly caused heavy losses, particularly to sheep growers. There were no losses last year from liver flukes in the area covered by the campaign.

In hog-cholera control work a great increase was recorded in the production of clear antihog-cholera serum. This is a more refined product than that previously in general use. In establishments licensed by the department to produce antihog-cholera serum the principle of pasteurization was introduced. Pasteurized clear serum safeguards livestock from possible contamination with harmful bacteria. As it is now made in the licensed establishments, the serum is either sterile or of very low bacterial content when marketed.

Animal-quarantine regulations designed to exclude foreign plagues were enforced, as usual, during the year, and the country was kept free of foot-and-mouth disease, rinderpest, contagious pleuro-pneumonia of cattle, surra, and other dangerous livestock maladies. The

beneficial effect of all these disease-control activities is shown by the fact that in recent years less than 2 per cent of the carcasses handled in federally inspected slaughterhouses have been condemned in part or in whole because of diseased conditions.

Omaha Rate Case Decision

In livestock marketing an important development during the year was a decision by the United States Supreme Court, handed down February 4, 1930, upholding the authority of the Secretary of Agriculture to prescribe rates for the handling of livestock on a commission basis at public stockyards. This case was commonly known as the Omaha commission men's rate case. The decision, besides sustaining the Secretary's right to prescribe reasonable rates, held that the rates he had prescribed were not confiscatory. Proceedings have been instituted to determine the reasonableness of the commission rates charged at other public stockyards. Studies of stockyard rates and property values are under way to determine what rates are necessary to give a fair return.

At a conference held in Chicago on October 22, 1929, at the invitation of the Secretary, resolutions were adopted to eliminate unfair and uneconomical practices in the packing industry. All branches of the meat-packing industry were represented. The resolutions banned secret rebates, the giving of premiums, the selling of goods below a reasonable market value to injure competitors, the issuance of misleading statements concerning the grade, quality, condition, and origin of packing-house products, and other practices held inconsistent with modern business principles.

DAIRY RESEARCH AND SERVICE

Increased utilization of dairy by-products was promoted by the Bureau of Dairy Industry by developing, standardizing, and assisting manufacturers to apply a new method of making casein. This grain-curd method was adopted at a number of plants. It enabled them to produce a superior product which immediately commanded a higher price. Casein is the principal material in cheese. Commercial casein is used extensively in another form in making paper. Casein is used also in making glues, paints, fungicides, plastic products, and insecticides.

Over half of the 51,000,000 pounds of casein consumed last year in the United States came from abroad. The new tariff act increased the duty on casein. This fact and the grain-curd method of making casein should widen the market for the domestic article. It would require about a billion pounds of skim milk to produce the casein that we have heretofore imported annually. If the United States made all the casein it needs, its farmers would get annually about \$3,000,000 that now goes to other countries, and they would get it for a dairy by-product, skim milk, which is hard to sell at any price in some parts of the country.

Our imports of casein were large in the past, partly because low costs of production in some other countries made it possible to sell the imported product in the United States at a price that discouraged domestic production. Prices received by the domestic manufacturers

were so low and irregular that casein manufacturing was seldom profitable and the manufacturer had not much inducement to make casein of high quality. As a result paper coaters could not depend on the quality of the domestic casein supply as a whole, though many producers turned out a good article. These difficulties ought now to disappear. At present casein is high enough in price to be a fairly satisfactory outlet for skim milk. The increased tariff on casein should maintain the price at a favorable level, provided our casein industry meets the demand of the market as to quality. It is striving to do so. When the Bureau of Dairy Industry called attention through the press to its grain-curd method for making casein, numerous casein manufacturers sought aid in putting the method into practice. There is a good inquiry from paper mills for ample and regular supplies of the grain-curd product. This is significant because paper making takes more than 75 per cent of the casein consumed in this country.

Assistance Given to Manufacturers

Technical help was also given by the Bureau of Dairy Industry to manufacturers of butter, American and Swiss cheese, and concentrated sour skim milk. The bureau carried on this work in cooperation with the State colleges of agriculture. In one instance an association of farmers' cooperative creameries was helped to improve its manufacturing methods; as a result about \$300 a week was added to the sales of the member creameries. A cheese factory, by the use of manufacturing methods developed in the bureau, raised the quality of its product to an extent that increased its profits several hundred dollars a month. Many other dairy-products factories reported to the bureau that they had increased their profits by improving their operation and management methods as recommended by the bureau.

The bureau developed and improved methods for the manufacture of lactose, or milk sugar, which constitutes a third of the solid constituents of milk. Research on this problem continues on three lines—to reduce manufacturing costs and increase yields; to convert the present milk sugar of commerce into a sweeter and more soluble form, better for table use; and to develop methods of fermenting lactose into products having a market value. In the manufacturing problem distinct advances were made. Valuable food proteins are discarded before the sugar is crystallized in the usual commercial processes. The bureau improved a process whereby lactose is crystallized from concentrated whey in a manner that leaves the albumen in its natural state for further purification. This was an important step toward the economic use of milk by-products, a year's supply of which is estimated to contain nearly a billion and a half pounds of milk sugar.

New facts of potential value to the cheese industry were developed by the bureau during the year in studies of the bacteria used as starters in cheese making. Fancy Swiss cheese results from the combined action of several kinds of bacteria, which produce the desired end only when a definite balance is maintained among them. Too many or too few bacteria of a particular group may materially affect the quality of the cheese. The bureau's discoveries should give increased control of the bacteria present in cheese making.

A process for separating albumen from whey without injuring its emulsifying or whipping properties was perfected. An experiment was started to determine whether the product can be used advantageously in ice cream. Another possibility is the utilization of albumen in modified milk for infants.

Dairy Herd Improvement

In the breeding of dairy cattle, research in the bureau developed principles which, if widely applied, should greatly increase the productivity of dairy herds. Modern breeding methods, carefully and intelligently followed, can develop strains of dairy cattle that are pure in inheritance for high production. The dairy herd-improvement associations, which number more than 1,100 in the United States, are an important means of translating dairy science into dairy practice. These associations are local cooperative groups of dairy farmers. They are organized by the State colleges of agriculture in cooperation with this department. They keep precise records which serve to show how much room for improvement there is in the efficiency and economy of milk production generally. It is highly significant, for example, that the average milk production of the cows handled by the associations is close to 7,500 pounds a year. The average milk production for all the cows in the United States is about 4,600 pounds. As yet only about 2.5 per cent of the dairy cows in the country are included in the dairy herd-improvement associations. As the proportion increases, the country's milk production per cow should increase.

Records compiled by the associations show that only about a third of our milk cows earn a profit, a third return just about what it costs to keep them, and the rest are carried at a loss. Study of the association records shows the dairy farmer how to increase his dairy profits by selling unprofitable cows. But culling, though it raises the average production of a herd, is costly because the butcher's price for the culled animals does not equal what has been spent to rear them. The obvious remedy is better breeding so that fewer low-producing cows will need to be culled from the dairy herds.

Feeding and Management

Success in dairying depends not on breeding alone, of course, but also on the feeding and management of the dairy herd. The Bureau of Dairy Industry studies feeding and management problems and helps dairymen to apply the results achieved. It announced last year important results in the utilization of pastures. In experiments at Huntley, Mont., remarkably economical milk production was obtained by feeding alfalfa exclusively or as the main part of the ration.

WILD-LIFE CONSERVATION AND CONTROL

This year marked the beginning of a 10-year national program for the establishment of refuges for migratory game birds. Systems of refuges for these birds are essential to carry out our treaty obligations with Great Britain for the protection of the species that twice

each year pass between the United States and Canada. With funds provided at the beginning of the fiscal year for the administration of an act authorizing these refuges, the Bureau of Biological Survey began nation-wide investigations of areas recommended as suitable. The food resources for wild fowl were studied on more than 3,700,000 acres, involving 189 units in 48 States. Eighty-nine of these units were found suited, from a biological standpoint, to the object in view. On 40 of the units, involving approximately 1,225,000 acres in 24 States, land-valuation surveys looking toward purchases were made.

Migratory-Bird Refuges Established

Two refuge areas on the public domain were set aside by Executive order, one of 12,000 acres in Montana and one of 20,000 acres in Oklahoma. The Migratory Bird Conservation Commission created under the act approved the purchase of one area of more than 32,000 acres in South Carolina, and another of more than 5,000 acres in Colorado, at an average price of \$1.13 an acre. Other areas aggregating 56,000 acres were recommended for purchase and await the action of the commission. This is excellent progress toward the completion, within the 10-year period, of a program that will provide a network of Federal refuges covering the important flight lines and the wintering and breeding resorts of our migrant game birds.

Under separate acts of Congress for the creation of migratory-bird refuges, progress was made on one refuge at the mouth of Bear River, Utah, and initial steps were taken for establishing another in the Cheyenne bottoms in Kansas. The former, which covers more than 56,000 acres of land and water, will provide a large fresh-water area for wild-fowl breeding, feeding, and resting in a locality where wild ducks formerly perished in thousands from disease. Engineering work has already much lessened the menace to the birds. When completed, the refuge will help to protect the wild-fowl resources not only of Utah but of adjacent and distant States, as demonstrated by bird-banding operations of the Biological Survey. The migratory-bird refuge in the Cheyenne bottoms was authorized by Congress on June 12, 1930. Data previously gathered enabled the department to proceed in acquiring needed land and water areas that will cover about 20,000 acres.

Changes in Conservation Laws

In December, 1929, the department decided to reduce the bag and possession limits on ducks and geese with the opening of the hunting season of 1930-31. Exhaustive field investigations had shown the necessity for the reduction, which was strongly recommended by the principal game-protective associations and by State game commissioners. It was urged also by the advisory board set up under the migratory-bird treaty act. Years are required to increase the number of ducks and geese and to provide enough resting and feeding sanctuaries. An immediately beneficial effect should follow restrictions on the annual kill by hunters. With the opening of the hunting season in the fall of 1930, the limits were reduced from 25 to 15 a day on ducks and from 8 to 4 a day on geese; and a possession limit was

prescribed of 30 ducks and 8 geese. Sportsmen themselves must exercise restraint if wild-fowling as a sport is to continue.

International wild-life protection entered a new phase with the passage of the tariff act of 1930, under the terms of which the principle of the Lacey Act governing illegal interstate transportation of wild animals or parts thereof is made international in scope. No wild mammals or birds or parts thereof of species specially protected in a foreign country may be imported into the United States unless accompanied by a certification of the United States consul for the consular district in which the point of export is located declaring that the animal or part thereof was not acquired or exported in violation of local laws or regulations. The new law should have a salutary effect.

Progress in Rat Control

The common house rat is the most destructive rodent in the United States. Besides menacing human life, it takes heavy toll of growing and stored crops and does much damage to other property. Recent experiments by the Bureau of Biological Survey demonstrated that red-squill powder is effective in rat control and relatively harmless to human beings and to livestock. Red squill is a wild perennial plant of southern Europe, with a large bulb from which the powder is made. The experiments showed that the powder can be produced at comparatively low cost. No other known rat poison combines the same advantages. Rat-control campaigns, in which the use of red squill was recommended, have had marked success.

FOOD AND DRUG ADMINISTRATION

Enforcement of the laws within the jurisdiction of the Food and Drug Administration, though primarily intended to protect consumers, also benefits producers. This is particularly true of the farmers. Food products that reach the market in a raw state are seldom subject to adulteration. Food products that have to be processed before reaching the consumer can be, and often are, adulterated. When this is done in the manufacturing process, the producer of the raw materials suffers along with the consumer of the manufactured commodity. The demand is lessened. This was illustrated in a type of adulteration against which action was taken under the food and drugs act in November, 1929. More than 5,000 cases of canned tomatoes were seized at various points because analyses showed that they were adulterated with water. Every pound of water illegally incorporated in the product deprived the farmer of a legitimate demand for an equal quantity of tomatoes. The sale of water at the price of canned tomatoes is a cheat to which reputable canners do not lend themselves. In checking the imposition the Food and Drug Administration improved the market both for raw tomatoes and for the honestly processed article.

Prior to the enactment of the food and drugs act, canned goods were a comparatively unimportant item in the American dietary. Such goods were often of uncertain quantity and quality and were mostly used where fresh food products could not be obtained. Cans were seldom full of the food they purported to contain. Often they contained an insignificant amount of food with an excessive amount

of water. This condition was changed following the passage of the food and drugs act. Cans were required to be filled with the foods mentioned on the labels, and the use of liquid exceeding the proportion necessary for processing was prohibited. Rigid and continuous enforcement of this rule made the slack-filled can a rarity. The insistence on a full can increased the demand for the products of the farm, not merely by preventing fraudulent adulteration, but by increasing the confidence of the public in canned goods.

Spoilage by Freezing

Sometimes action is necessary which protects the ultimate interests of the farmers in a manner that seems costly and burdensome at first. In January last much citrus fruit in the Rio Grande Valley of Texas was damaged by frost. Freezing causes a physical breakdown in citrus fruit. In a week or so the inside dries and becomes unfit to eat, though the fruit may still look all right on the outside. After a severe freeze, some growers rush frost-damaged fruit to the market though it may be worthless when delivered to the consumer. Such action discredits the producing region and tends to reduce the demand for the sound fruit that may be produced subsequently. The more farsighted growers understand this and do not ship frost-damaged fruit. They can not, however, restrain others less conscientious or less interested in the long-time prosperity of the industry. Accordingly, an inspector of the Food and Drug Administration, in cooperation with the State authorities of Texas and with leaders of the citrus industry in the Rio Grande Valley, showed growers how to tell whether their fruit had been hurt enough to make it unfit for shipment. He urged the destruction of seriously damaged fruit, pointing out that if shipped it would be seized under the food and drugs act. As a result a great quantity of fruit was voluntarily taken from the trees by the growers and destroyed. Only a small amount was shipped contrary to the warnings given and had to be seized. The action taken on this question helped to maintain the reputation of the Texas citrus industry. The Food and Drug Administration has been adversely criticized for adopting an "advisory before the act" attitude in situations of this kind, but the method taken assures a much more adequate and widespread protection of the consumer and likewise of the permanent interests of the producer than could be achieved by relying on strictly punitive and confiscatory measures. Educational methods make seizure or prosecution largely unnecessary. During the year many other products were brought into conformity with the law either through legal action or in appropriate instances by the advisory method just described.

Insecticide Act

Results achieved in the administration of the insecticide act illustrate the protection given by such regulatory legislation. Calcium arsenate, which is widely used to protect cotton against the boll weevil, is produced on a large scale by 21 manufacturers whose aggregate output exceeds 25,000,000 pounds annually. In the fiscal year

ended June 30 last, the plants of these manufacturers were inspected, and samples of calcium arsenate were collected. Samples were also collected from dealers and distributors. Ninety-four per cent of the samples were entirely satisfactory both in composition and in labeling. The remaining 6 per cent of the samples were of a proper composition, but were not correctly labeled. Steps were taken to remove this defect.

Import Milk Act

Substantial benefits have accrued to the American dairy industry and to the consumers of dairy products from the import milk act, which was approved February 15, 1927. This measure has reduced our imports of milk and cream materially. In the year ended March, 1930, our imports of milk from Canada totaled only 29,646,561 gallons, against 53,858,992 gallons imported in the year ended March, 1927. This reduction is largely attributable to the exclusion of milk produced under conditions below the standards of sanitation imposed by the import milk act.

Farmers have a substantial interest as consumers in the enforcement of these regulatory laws. They are large buyers of manufactured food products and thus share with city dwellers in the benefits of the food and drugs law. They are specially protected by action taken to prevent the marketing of fraudulently labeled stock remedies and of adulterated or misbranded feedstuffs. Twenty-five seizures of fraudulently labeled stock remedies were made during the last fiscal year. In many cases manufacturers changed their formulas voluntarily or altered labels after their attention had been called to the necessity for so doing. Farmers reaped a twofold benefit. They saved money that would otherwise have gone for worthless goods and avoided injuring their livestock with harmful products.

EXPERIMENT STATIONS

Research at the State experiment stations continued to expand under the stimulus of increased financial support from Federal, State, and local sources. The funds available for these institutions during the last fiscal year totaled about \$17,000,000, approximately a fourth of which, or \$4,335,000, was contributed by the Federal Government. As provided by the Purnell Act of 1925, Federal support to the State experiment stations has been increased \$10,000 annually for each State during the last five years. The increase has now reached \$60,000 annually for each State, the maximum increase provided by the Purnell Act. Previously under the Hatch Act and Adams Act the Federal Government provided \$30,000 annually to each of the States; hence the total annual contribution to each State is now \$90,000. The income of the stations has been increased to a still greater extent from State and local sources. As a result they are cooperating effectively with one another and with this department in a research program that covers practically every phase of agriculture and rural life. They are giving special attention to agricultural economics, home economics, and rural sociology, as authorized by the Purnell Act.

Seven Thousand Research Projects Under Way

More than 7,000 research projects are under way at the experiment stations. These studies, in which the work of one station is in large measure coordinated with that of others and with the work of the United States Department of Agriculture, deal with both the technical and the economic problems of farm production. They deal also with marketing and distribution and with rural-home and rural-community problems. In general the experiment stations emphasize local or regional needs, while this department deals with farm problems largely from a broad national viewpoint. This division of effort has justified itself in practice and promises increased benefits in the future. The Office of Experiment Stations represents the Federal Government in administering the Hatch, Adams, and Purnell Acts.

Research at Insular Stations

The Office of Experiment Stations supervises the use of the funds appropriated by Congress for the maintenance of agricultural experiment stations in Alaska, Porto Rico, Hawaii, Guam, and the Virgin Islands. The Alaska station made noteworthy progress in developing strains of beef and dairy cattle suited to the Territory. Successful experiments in dairying were made in the Matanuska Valley. Satisfactory results have followed the establishment of joint control of the Hawaii Agricultural Experiment Station by the United States Department of Agriculture and the University of Hawaii. This was provided for in an act of Congress passed May 16, 1926, to extend the benefits of the Hatch Act and supplementary acts to Hawaii. Experiment stations previously maintained separately by the department and by the University of Hawaii were combined.

The experiment station in Porto Rico helped to restore the agriculture of the island following the destructive hurricane of 1928. It was especially active in repairing the damage to coffee plantations and citrus orchards. Research men attached to the station demonstrated that leaves of banana trees, planted extensively as temporary shade for coffee, furnish a fiber that can be used in making coffee and sugar bags. This indicated a possible saving of a million dollars or more annually to Porto Rican farmers. From coffee plantings that withstood the storm, the experiment station supplied enough seed of the Excelsa variety to replant nearly 2,000 acres. It helped to get a commercial precooling plant for citrus fruits and pineapples erected at San Juan. Fruit handled in this plant reaches New York in a much better condition than fruit not so handled.

The experiment station in the Virgin Islands developed a new variety of sweetpotatoes which yields 50 per cent more, is of better quality, and keeps better than the common varieties. Planting of the new variety is going forward rapidly. The station has also demonstrated the practicability of growing vegetables to improve the local dietary and to ship to New York. The Guam experiment station has brought about an improvement in the livestock of the island; encouraged the planting of better forage crops; demonstrated the feeding value of copra meal; and helped to bring about the commercial planting of pineapples for canning.

HOME ECONOMICS

Research in the Bureau of Home Economics touches the general farm problem at some vital points. It reveals deficiencies in farm living standards and indicates remedies. It shows that in many areas a vicious circle is formed between low income and poor diet, poor health, and lowered production. Other unsatisfactory aspects of family living on the farm result from lack of skill in the expenditure of the farm income. The food purchased may be poorly chosen; the clothing purchased may be ill adapted to farm needs; farm homes may be equipped less efficiently than the means available would permit; and lack of information on commodity values may cause much waste in household buying.

The bureau recently drew attention to the dietaries reported by 61 families in a rural district of South Carolina as showing the interdependence of income and family living standards. Pellagra, a chronic disease directly caused by badly selected food, is prevalent in this area. The average farm income available did not suffice for an adequate diet. Poor diet caused disease, and disease impaired the economic efficiency of the group. It was evident that the needs of the region required the attention of the economist as well as of the home economist. It was necessary to offer suggestions looking both to improved farm practices and to a better use of the available farm income.

Preliminary surveys in other regions indicate that similar conditions exist there. The department has recognized the complex character of the family-living problem by studying it from several angles simultaneously. Thus the Bureau of Home Economics is co-operating with the Bureau of Agricultural Economics and with the Kentucky Agricultural Experiment Station in a study of land utilization and living conditions in eastern Kentucky. In this study it is the task of the Bureau of Home Economics to show wherein the standard of living is wanting.

Rural Diet Deficiencies

The Bureau of Home Economics has found that the diet of city dwellers has made more progress toward a scientific ideal in recent years than has the diet of farm dwellers. City people are eating more vegetables and fruits. On the farms, though the use of fruit and vegetables is greater than it formerly was, these foods still do not form a sufficient part of the diet. Reports of the foods used by 2,402 farm families in nine States indicated that dietaries could be much improved in some areas by the use of more fruits and vegetables. Milk consumption on the farms in all these States was lower than it should be. In the State reporting the least use of milk, pellagra is common.

Practical Value of Nutritional Studies

Research done by the bureau on the vitamin content of certain foods has a twofold value to the farm family. In the first place it shows how diets may be improved. Second, such research indicates that certain products ought to have a wider market. It has been

demonstrated, for example, that the watermelon is a good source of vitamins A and C and contains small amounts of vitamins B and G. Study of the vitamin content of spinach showed that three varieties were about equal as sources of vitamins A and B. But one of these varieties is less potent than the others in vitamin C and loses more of the vitamin C in the canning process. Such knowledge has obvious practical value in view of the importance of an adequate vitamin content in the diet. As is well known, many serious nutritional disorders result from an inadequate supply of vitamins. Besides studying the composition, the bureau experiments also with the cooking of foods. It is cooperating with specialists in animal husbandry to test the palatability of meats. Facts developed by this research will be useful to livestock producers as well as to meat consumers.

Textile Utilization

In an effort to encourage a more intelligent use of cotton and wool produced in this country the bureau studies the utilization of textiles, publishes designs for clothing and household articles, and assists textile manufacturers in learning more about the consumer's needs. In this way the interests of both the producer and the consumer are promoted. The production of desirable types of cotton and wool materials is encouraged and home makers are helped to make a better selection of fabrics. In cooperative studies with other bureaus of the department the Bureau of Home Economics inquires into the relationship between different grades and qualities of cotton and wool and the value of the fabrics woven therefrom. Fabrics produced by manufacturers under scientifically controlled conditions are given laboratory and wearing tests. The interest shown in the textile studies by manufacturers and consumers is some evidence that their potential value is appreciated.

PROGRESS IN WEATHER FORECASTING

Increased appropriations made possible marked expansion of the Weather Bureau's service along airways. This now includes continuous 24-hour service along approximately 6,000 miles of airways and a less frequent exchange of reports for some 7,000 miles. The hourly reports are transmitted mostly by means of teletype systems maintained and operated by the Department of Commerce. One circuit extends from Boston to Richmond; another from Portland, Oreg., to San Diego. These are united by the main transcontinental line from New York to San Francisco, which has two channels from Omaha to Cleveland—one by way of Chicago and the other through Kansas City, St. Louis, and Louisville.

On the transcontinental line between New York and San Francisco a network of stations is maintained, covering a strip about 150 miles either side of the airway, which report every three hours to central airport stations at Cleveland, Fort Crook (Omaha), Salt Lake City, and Oakland (San Francisco). Summaries and short-period forecasts prepared at these centers are broadcast from Department of Commerce radio stations to aircraft in flight. They are picked up also by numerous airports and by others interested. Dur-

ing the fiscal year 1931 the airways service will be expanded still further with the aid of additional funds. Hourly reports will be organized on about 3,000 additional miles of airways, and the 3-hour forecast service will be extended to include the Southeastern, Southern, and extreme Northwestern States, with centers at Atlanta, Dallas, Fort Worth, and Portland, Oreg.

Reports from Ships at Sea

Synoptic weather reports from ships at sea were briefly described in the report for 1929. Under the international agreement concerning these, each nation is responsible for enlisting a selected number of ships to radio regular reports at least twice a day to designated shore stations. The present program includes about 21 American, 31 British, and 5 French ships. Ten German ships are expected to report in the near future. On any one day only a fraction of the whole number of enlisted ships are in position to render reports.

These reports have great value to the forecasters of the bureau, as well as to those of all other national services receiving them. The great continental areas are dotted with numerous stations which make at least two reports a day. Without ship reports the vast ocean areas are a complete blank, and the forecaster's picture of the atmosphere is incomplete. Ship reports enable him to sketch in and tie together both land and sea conditions. The combination gives from observation to observation the picture of the ever-changing circulation of the air over the whole Northern Hemisphere. The data for the vast ocean areas are still scanty and incomplete, but new reports are being added each year, and improve the basis for better and more complete forecasts.

THE NATIONAL FORESTS

The national forests are administered with a view to obtaining from them the largest net total of public benefits. Their resources are very great. During the year their net area—that is, the area of federally owned land within their boundaries—was increased by 340,297 acres, to a total of 160,090,817 acres. Their use by the public exceeded in various particulars all previous records, with a greater cut of timber, greater total receipts for uses involving a charge, and a greater number of recreation visitors by several million than in the preceding or any earlier year. Through their wise development, their scientific management, and careful safeguarding of their productivity their public value and services can be made to increase still further and immensely.

The first need of the West that national-forest administration aims to meet is that for water. This necessitates the working out of methods and plans of use that will insure the preservation of a suitable vegetative cover on important watersheds. Certain of the national forests were created specifically to protect Federal reclamation projects and at the request of the Reclamation Service. Watershed protection is a complex matter. While it is a primary objective of national-forest administration, it can not be pursued as an independent objective. To be fully serviceable the national-forest land areas

must be managed with a view to utilizing their capacity to grow timber crops and forage crops along with their capacity to regulate water flow. The most difficult problems of national-forest administration lie in combining and coordinating the water-control function with the utilization of the natural products of the soil.

The Protection Problem

Severe drought made protection of the national forests against fire in the summer and fall of 1929 exceptionally difficult. Never before in the history of national-forest administration had the western fire season had so late a close. The expenditures of the year for fire suppression alone exceeded \$3,400,000. The estimated damage to the Federal properties exceeded \$4,300,000, of which nearly \$4,000,000 represented timber and reproduction destroyed. The fires burned over more than 978,000 acres of land within the national forests, of which more than 799,000 acres were owned by the Government. Only twice has a greater area been burned over, and only three times—in 1910, 1919, and 1926—has the estimated damage been greater. Of the area burned over, 96 per cent was in the national forests of the West. Both the expenditures for fire suppression and the fire damage fluctuate greatly from year to year. The expenditures, which have averaged for the last decade \$1,280,000, were less than \$320,000 in 1923, as against more than ten times that amount in 1929. The damage averaged for the decade \$1,363,000, but was less than \$181,000 in 1923, as against a high in 1926 of more than \$4,560,000. The protection problem centers in the bad fire years. Bad years are due to precipitation shortages, high temperatures, low atmospheric humidity, excessive wind, and severe lightning storms. The climate, the character of the forest, the topography, and the inaccessibility of great areas make protection in the West extremely difficult always. The years of peak load necessitate the employment of hundreds and even thousands of men on the fire lines.

Most Damage Done by Large Fires

Most of the damage and outlay are caused by relatively few very large fires. More than half the fires are put out before they have covered one-fourth of an acre. More than half the rest are held to less than 10 acres. Only a small percentage exceed 100 acres. In California last year, where fire-control conditions were exceedingly unfavorable, out of 202,000 acres burned over by 1,416 fires of all sizes, 184,000 acres, or 91 per cent, was covered by 10 per cent of the fires, which covered 100 acres or more each. Area alone, however, is not a satisfactory index of the damage done or the efficiency of the control system. Grass fires may cover a large acreage without causing much loss, and different types of timber vary widely in their susceptibility to damage. The Forest Service is adjusting its system of fire control to the degree of difficulty of the relative values at stake, and their susceptibility to damage in each case. This is done by setting up for each forest standards of satisfactory performance in keeping down the area burned over in bad years.

The standards vary from 0.1 per cent of the total area to 2.5 per cent where there is little of value to protect—for example, where

the growth is only grass or brush and the watershed values involved are inappreciable. When the standard of satisfactory performance thus established is compared with what is actually being accomplished, the problem of protection is given new definiteness.

Of the 149 national forests, 74 are rated as now receiving satisfactory protection; 37 are on the border line; 38 are definitely substandard and show a ratio between the area burned in bad years and the total area that averages about five times what the standards set up would allow. It is urgently necessary to give better protection to these substandard forests, which are the critical spots, taking the greater part of the outlay for fighting large fires and accounting for the greater part of the fire losses. This calls for strengthening the preparedness of the protective organization to function swiftly and effectively under the stress imposed by the bad years.

Preparation for Forest Protection

Preparedness calls for a specially trained and competent personnel, properly organized and located; for advance plans of action, including arrangements for obtaining, transporting, provisioning, equipping, and officering additional manpower in such quantities as may be requisite; for efficient systems of detection, communication, and transportation in the form of observatories, telephone lines, roads, trails, and the like; and for adequate supplies of such forms of equipment as trucks, power and hand pumps, specialized machinery, tools, and many other accessories of fire fighting. In the past the Forest Service has been greatly restricted, in comparison with the protection needs, in making the expenditures necessary for preparedness. The appropriations for the current year, however, afford much greater latitude for preparedness than has ever existed before. To equip the critical forests adequately with the permanent improvements necessary for economical and efficient protection will take years; but the line of attack upon the problem of fire control that has now received legislative sanction should progressively safeguard the forests and increase their usefulness.

Forest protection includes protection against the ravages of destructive insects and tree diseases as well as against fire. The three are related, for large quantities of dead timber greatly increase the fire hazard, while fires increase the susceptibility of the forest to insect and disease attack. As intensive forest management becomes possible, harvesting the timber crop can be made a means of putting the forest into much better condition for protection through reduced fire hazards, applying measures of forest sanitation to check tree diseases and insect infestations, and making all parts of the forest easy to reach. Regulated grazing also can contribute to protection. But as a rule the national forests have not reached the development that permits intensive management. They are in a transition stage between the wilderness period of their history, when even the most elementary requirements for protection were lacking, and the period when all their resources will be in full use. In consequence, the problem of protection is still largely an isolated problem rather than a matter of creating and maintaining, as a part of resource development and management, the right conditions.

Trends in Western Forest Ownership

Since 1891, the year in which the President was authorized to create reserves, the western system of national forests has been moving gradually toward its completion. At the same time the available area has been progressively diminishing through disposal of the public-domain timberlands under other laws. Nevertheless there is left a considerable acreage of unreserved and unappropriated public land having forest values for timber production or watershed protection that justify and make desirable its inclusion in national forests.

Some of the forest land that has passed into private ownership since the policy of reservation was first proposed is likely to gravitate back into public ownership after its timber has been removed. In the Lake States tax delinquency and land abandonment have reached serious proportions; they are beginning to threaten in parts of the South, and they are creating acute local problems in some Western States. There is a distinct possibility of the building up of a new public domain, but this time in the hands of the States, which become the reluctant recipients of what the private owner throws away. In some parts of the West a growing disposition exists to look to the Federal Government for relief from the accumulation of abandoned cut-over lands in State ownership.

Some small relief is taking place under the exchange laws. The purpose of these laws is to facilitate the consolidation and rounding out of national forests. In or near many are private lands which the Government should acquire to form more logical administration units. The Forest Service may negotiate exchanges with the owners of lands within the forest boundaries, and in some cases up to 6 miles distant from the boundaries. For the lands acquired, lands, timber, or both may be exchanged; but usually the Government obtains land with more or less timber and gives timber only. Lumber companies wishing to operate national-forest stumpage under the customary timber-sale regulations can thus sometimes pay in land or in land and standing timber instead of in cash. Often they turn over lands with much more timber on them than they receive, being induced thereto by the more favorable location for them of the timber obtained. It may be close to lands that they are already logging. In other cases cut-over lands are turned over. In this way some land which otherwise might eventually be forfeited to the States through nonpayment of taxes is kept productive. The exchange policy should in time afford an appreciable, if minor, relief from the consequences of temporary private ownership assumed solely for the sake of the timber.

Exchanges are also made with States. Under the school-land and other grants, the Western States received extensive rights to lands subsequently included in national forests. A number of these States have received solid blocks of land in exchange for scattered sections in the national forests. Some of the lands have been outside the national forests, but Idaho, Washington, Oregon, California, Montana, South Dakota, Michigan, and Colorado have obtained or are in process of obtaining blocks of timberland from the forests. These areas are suitable for permanent forest administration by the States themselves, and the outcome will probably be State forest enterprises essentially like that of the Federal Government. As tax-

reverted cut-over lands accumulate, they will presumably necessitate State plans for their consolidation and administration.

More than four-fifths of the forest land west of the Plains, not including that in Alaska, is now in public ownership. This includes national forests and national parks, State and municipal forests and parks, Indian reservation and open public domain forest lands, and State forest lands for which no policy of administration is in sight. Private ownership accounts for the rest. Every effort should be made to encourage and facilitate private forestry on this land. Nevertheless, public ownership will eventually have to take over more of the western forest area. Steps should be taken to place under administration for forest purposes, by the appropriate agencies, both the remaining timbered areas of the public domain and other timberlands subject to Federal control whose permanent status is not yet determined. It is desirable that the States also should undertake greater responsibilities for the permanent administration of forest lands.

The Eastern National Forests

Although several of the eastern national forests were created by reserving portions of the public domain and 38 per cent of the Federal land in the eastern forests has come through such reservations (chiefly in Arkansas, Minnesota, Michigan, and Florida), the eastern system of national forests is being built up under a policy of acquisition. The law of March 1, 1911 (the so-called Weeks law), provided for the purchase of "lands located on the headwaters of navigable streams or those which are being or may be developed for navigable purposes." Although the law set no regional limitations on purchases, it was accepted as providing for the building up of a small system of eastern national forests that would be confined to the mountain ranges of the southern Appalachians and to the White Mountains of New Hampshire and southwestern Maine. It was believed that Federal administration of well-chosen strategic areas totaling 5,000,000 acres in the southern Appalachians and 1,000,000 acres in the White Mountains could lead the way to right management and use of the forests of the two regions. But as acquisition advanced, forest exploitation also advanced. The result was to enlarge in these regions the area requiring Federal administration to protect navigable streams, as well as to make clear that protection should be extended to various similar areas outside the regions.

Beyond that, Congress in 1924 broadened the Weeks law by directing the Secretary of Agriculture to recommend for purchase lands necessary for the production of timber, and also by removing the restriction which had confined acquisitions for watershed protection to lands "located on the headwaters of navigable streams." This amendment was part of the Clarke-McNary law, a comprehensive measure enacted after an inquiry by a Senate committee had shown the need for enlarged Federal activities in forestry. Since the original program was formulated, and particularly since the Clarke-McNary law was passed, additional purchase areas have been established in Arkansas, Pennsylvania, the Lake States, and the southern pine region. In these areas 886,167 acres had been acquired up to

the close of the last fiscal year, together with 2,527,126 acres in the two original regions.

The present program is limited to putting into effect the intent of the two laws providing for forest-land acquisition. It is not a program based on a broad survey of the requirements of the eastern forest situation. It calls for the acquisition of a total of approximately 9,500,000 acres, of which the major part will be added to some 6,000,000 acres already owned or under contract of purchase by the Federal Government to protect the headwaters of navigable streams. The rest will be acquired primarily to aid in timber production and to demonstrate forestry practice in the southern pine and the northern Lake States regions. The Federal Government already has about 1,800,000 acres in these regions, mainly derived from the reservation of areas of public lands. If this program is to be carried out within a reasonable time, the rate of acquisition will need to be substantially accelerated. A forward step was taken by Congress, near the close of the fiscal year, in authorizing appropriations up to \$3,000,000 in each of the fiscal years 1932 and 1933.

The completed program will provide an eastern system of national forests containing some 16,000,000 acres of Government-owned land, chiefly in areas selected for their value in protecting the headwaters of the principal navigable rivers, in other words, chiefly mountain lands. But the needs of the East for permanent forests to control floods and erosion will not be met by this program. It will take care of only a minor part of these needs. Still less will it meet the needs of the East for public ownership and management to insure and promote timber production. In the eastern half of the United States approximately 350,000,000 acres are classed as forest land. In addition there are many million acres of marginal and submarginal farm lands which might better be used for forest purposes than for farming, and which will sooner or later largely revert to forest. Of the present area of eastern forest land, more than 95 per cent is privately owned. The practice of forestry by private owners is relatively rare. Private forestry should be encouraged and promoted by every means consistent with sound public policy, but it can not be expected to restore to productiveness all of the cut-over and burned-over lands. Sooner or later eastern public forest land ownership on a far greater scale than has yet been thought of will become inevitable. While the responsibilities and the burdens that will be involved may in the main be regarded as appropriately falling first on the States and local governments, both the magnitude of the tasks that will be imposed and the extent to which national interests are affected will almost surely make necessary substantial Federal participation along new lines.

FEDERAL-AID ROADS

Included in the Federal-aid highway system at the present time are 193,049 miles of the country's most important interstate and intercounty highways. Initial Federal-aid improvements were completed during the past year on 7,317 miles in this system.

Since 1916, when the Federal-aid policy was adopted, the Government has cooperated with the States in the improvement of 86,978

miles. Provision for the designation of the Federal-aid system was not made until 1921. Between 1916 and 1921 a considerable mileage was improved that was not included in the Federal-aid system when it was finally designated. The roads omitted were not considered of sufficient importance to warrant their inclusion, but, as Federal funds had been applied to their improvement, the States have been required by law to maintain them.

To permit the States to return these roads to the care of the county and township authorities, by whom they should properly be maintained, a plan has been developed under which the States may substitute for these unimportant roads outside of the system other roads in the system. Federal funds previously paid for the older improvements, supplemented with new funds as required, are applied to the newly included roads. As the substituted roads require more expensive improvements than the roads they replace, the mileage that can be improved with the transferred funds is less than the originally improved mileage. By such substitutions the mileage for the maintenance of which the States are held responsible has been reduced by 696 miles. By the relocation of previously improved roads in the course of stage construction, a further reduction of 64.2 miles has been made; so that the mileage now carried as a State maintenance responsibility is 86,218 miles. Of this total, 2,205 miles were in process of further stage improvement or reconstruction at the close of the fiscal year, so that the mileage classified as improved was reduced to 84,013 miles. At the close of the preceding year the mileage similarly classified was 77,944. Hence the net addition of "improved" mileage was 6,069 miles.

Status of Appropriations

At the close of the fiscal year 1929 the balance of Federal-aid funds authorized and not expended in the earlier years of the road-building program had been exhausted. It therefore became necessary to shape the work in accordance with the amount of the authorized funds for the current year.

For several preceding years unused authorized funds made it possible to carry on a program calling for an annual Federal disbursement ranging from \$80,000,000 to \$95,000,000, though in 1925 and afterwards the total sum annually authorized was only \$75,000,000. Out of this sum, after deduction of the administrative percentage, \$73,125,000 was apportioned among the States.

In the fiscal year 1929, for the first time since 1923, the amount obligated for new projects was within the amount of the year's apportionment. Thus curtailment of the program for the ensuing year and for succeeding years was foreshadowed. Federal-aid funds paid to the States during the fiscal year 1930 were smaller in amount than in any year since 1925. The amount paid, \$75,880,863, was more than \$6,000,000 less than in the preceding year and more than \$20,000,000 less than in 1925, when the accumulated balance of unobligated funds was greatest. As the rate of the initiation of projects had been reduced to the gauge set by the annual apportionments, the rate of payment upon projects was reduced accordingly. It was but little higher in 1930 than the \$73,125,000 apportioned.

For the fiscal years 1930 and 1931 the authorizations originally provided by Congress were \$75,000,000, the same as for the several years preceding. This sum established the rate of operation throughout the first half of the fiscal year. The apportionment in December of the \$73,125,000 originally available for the fiscal year 1931 merely permitted a continuation of the work at the same rate.

Additional Funds for 1931

In April, 1930, however, Congress authorized an additional appropriation of \$50,000,000 for the fiscal year 1931. It thus recognized the need of increased authorizations to restore the earlier rate of construction. Congress desired also to augment public work so as to provide employment. This additional sum, less the prescribed administrative percentage, was immediately apportioned among the States and was available at once for allotment to new projects. The States submitted projects at a materially increased rate. As a result the total obligation of Federal-aid funds during the fiscal year 1930 was \$102,000,000, considerably more than the amount obligated in any year since 1925. The amount obligated exceeded the corresponding amount for the fiscal year 1929 by more than \$32,000,000.

The effect of the increased authorizations in providing additional employment is indicated by the fact that in April, 1930, the number of men employed on Federal-aid road construction was 20,200, as compared with 16,200 in April, 1929. In May, 1930, the number employed was 31,400 and in June 35,800, as compared with 26,600 and 34,500, respectively, in May and June, 1929. In August, 1930, the number employed was 48,513. These figures represent only the men employed in the actual construction of the roads. They do not include the workers required to manufacture and prepare materials and equipment or those employed in transporting materials and equipment to the job.

Funds authorized for appropriation for the fiscal year 1932 were apportioned on September 1, 1930. Under ordinary circumstances this apportionment would not have been made until December. It was made earlier to provide increased employment for farmers and other sufferers from the effects of the drought. The newly apportioned funds are immediately available for allotment to new construction projects wherever such projects will furnish employment for drought sufferers.

Increase in Annual Mileage Indicated

The mileage initially improved during the past year was less than in any previous year since 1921. This was the natural consequence of the contraction of the program to the scale set by the \$75,000,000 authorizations. That the enlargement of the authorization to \$125,000,000 for the fiscal years 1931, 1932, and 1933 will be followed quickly by an increase in the mileage improved annually is indicated by the fact that the mileage of initial and stage construction already under way and approved is considerably greater than it was a year ago.

The mileage of initial and stage improvements under construction or reconstruction on June 30 was 9,915, as compared with 9,526 a

year previous. The mileage of both classes of improvement approved for construction or reconstruction at the close of the year was 3,469, as compared with the corresponding figure for the previous year, which was 2,898.

The net increases in the several types of construction during the year were as follows: Graded and drained roads, 1,041 miles; untreated sand-clay roads, 117 miles; untreated gravel roads, 661 miles; treated gravel roads, 118 miles; untreated macadam roads, 7 miles; low-cost bituminous mixed roads, 448 miles; bituminous macadam roads, 385 miles; bituminous concrete roads, 166 miles; Portland-cement concrete roads, 3,081 miles; block pavements, 38 miles; and bridges and their approaches, 43 miles. There was a net decrease in the mileage of treated macadam roads amounting to 36 miles, which made the total net increase 6,069 miles.

Total Improved Mileage

The total mileage classed as improved at the close of the year was as follows: Graded and drained roads, 12,449 miles; untreated sand-clay roads, 7,166 miles; treated sand-clay roads, 17 miles; untreated gravel roads, 28,608 miles; treated gravel roads, 482 miles; untreated macadam roads, 1,754 miles; treated macadam roads, 603 miles; low-cost bituminous mixed roads, 742 miles; bituminous macadam roads, 4,057 miles; bituminous concrete roads, 3,205 miles; Portland-cement concrete roads, 23,693 miles; block pavements, 905 miles; and bridges and their approaches, 332 miles; a total of 84,013 miles.

The total cost of the 7,317 miles of initial improvements and the 2,011 miles of secondary improvements completed during the year was \$193,648,149, of which sum \$82,158,757 was paid by the Federal Government. These payments extended over the period of between one and two years required to complete the improvements. In addition to the payments made during the year on the projects that were completed, payments were also made on other projects not completed. The total actual disbursements of Federal funds to the States amounted during the year to \$75,880,863.

Mount Vernon Memorial Highway

Construction of the Mount Vernon Memorial Highway from Washington to Mount Vernon, begun in September, 1929, was well advanced by the close of the fiscal year. The road should be ready for use in February, 1932, as planned.

Provision for the construction of the memorial road was made by an act of Congress approved May 23, 1928. This act authorized the Commission for the Celebration of the Two-hundredth Anniversary of the Birth of George Washington to select the route and approve the plans for the road. It directed the Secretary of Agriculture to cooperate in making the surveys, and to supervise the construction. The act authorized an appropriation of \$4,500,000. The Bureau of Public Roads surveyed two feasible routes. The commission, on January 24, 1929, selected a route beginning at the Arlington Memorial Bridge on Columbia Island and following closely the Virginia shore of the Potomac, a distance of approximately 15½ miles, to Mount Vernon. The plans provide for a pavement 40 feet wide

on a right of way of a minimum width of 200 feet, except through the city of Alexandria, Va. The grade and alignment are designed to permit a rapid and easy flow of traffic and a smooth blending of the highway into the natural roll of the land. This requires careful landscaping.

For the safety of traffic, all important crossroads are carried under or over the highway on grade-separating bridges. The minor roads intersecting at the grade will enter the highway from the two sides at points separated by a considerable distance, so as to avoid direct crossing of the principal traffic stream. At suitable points flared and divided roadways will facilitate the turning and parking of vehicles and permit visitors to halt for views of the river and the Capital City. A large terminal circle at Mount Vernon and tree-screened parking areas at this point will permit the expeditious loading and unloading and the orderly parking of many vehicles.

The first work was begun on the road in September, 1929, on a contract for the construction of a sea wall, the building of a cofferdam, and the supplying of stone for bridge facing. Contracts subsequently awarded provide for the construction of $2\frac{1}{4}$ miles of hydraulic fill, for $12\frac{1}{2}$ miles of dry-land grading and small drainage structures and incidental construction, and for 12 major bridges. At the close of the fiscal year 1930 the sea wall had been completed, four of the five hydraulic fills were near completion, and excellent progress had been made in the dry-land grading and the construction of the bridges. Tenders for the construction of the pavement are to be invited shortly after January 1, 1931.

ARTHUR M. HYDE,
Secretary of Agriculture.

FINANCIAL STATEMENT

Expenditures, Department of Agriculture, Fiscal Year 1930

Funds disbursed and obligated for work under the supervision of the Department of Agriculture during the fiscal year ended June 30, 1930, including road building, totaled \$177,961,928. These expenditures were distributed as indicated by Tables 1 and 2 and the tabulation following Table 1.

TABLE 1.—Expenditures classified by organization units

Organization unit	General activities (all objects except payments to States and road construction)	Payments to States (exclusive of Federal-aid road funds)	Road construction (including Federal-aid road funds)	Total
Office of the Secretary.....	\$1, 173, 571			\$1, 173, 571
Office of Information.....	1, 242, 000			1, 242, 000
Library.....	101, 995			101, 995
Office of Experiment Stations.....	394, 972	\$4, 335, 000		4, 729, 972
Extension Service.....	1, 781, 410	7, 662, 936		9, 444, 346
Weather Bureau.....	3, 462, 110			3, 462, 110
Bureau of Animal Industry.....	¹ 15, 412, 262			15, 412, 262
Bureau of Dairy Industry.....	717, 034			717, 034
Bureau of Plant Industry.....	5, 129, 752			5, 129, 752
Forest Service.....	15, 329, 892	3, 024, 508	\$9, 982, 296	28, 336, 696
Bureau of Chemistry and Soils.....	1, 561, 879			1, 561, 879
Bureau of Entomology.....	2, 320, 692			2, 320, 692
Bureau of Biological Survey.....	1, 615, 895			1, 615, 895
Bureau of Public Roads.....	² 1, 123, 479	(³)	80, 368, 428	81, 491, 907
Bureau of Agricultural Economics.....	5, 977, 182			5, 977, 182
Bureau of Home Economics.....	167, 500			167, 500
Plant Quarantine and Control Administration.....	⁴ 8, 401, 096			8, 401, 096
Grain Futures Administration.....	139, 042			139, 042
Food, Drug, and Insecticide Administration.....	1, 535, 986			1, 535, 986
Seed Loan Office.....	⁵ 5, 001, 011			5, 001, 011
Total.....	72, 588, 760	⁶ 15, 022, 444	⁶ 90, 350, 724	177, 961, 928

¹ Includes \$5,071,000 paid as Federal indemnities to livestock owners for animals destroyed in connection with tuberculosis eradication, and \$5,654,316 for meat inspection.

² Includes \$505,909 for highway research and service activities, paid from appropriation for Federal-aid road construction.

³ \$77,386,283, paid to State highway departments for Federal-aid road work, included under column "Road construction."

⁴ Includes \$4,440,617 for investigation and control of the Mediterranean fruit fly.

⁵ Includes \$4,992,071 for seed and fertilizer loans to farmers in flood, storm, and drought stricken areas and \$8,940 for collection of loans.

⁶ See tabulation "Payments to States and Road Expenditure."

Payments to States and Road Expenditures

(Analysis of "Payments to States" and "Road construction" included under Table 1)

(1) PAYMENTS TO STATES

Office of Experiment Stations:

Payments to State agricultural experiment stations and to Hawaii for research under Hatch, Adams, and Purnell Acts_ \$4, 335, 000

Extension Service:

Payments to State agricultural colleges and to Hawaii for extension work under Smith-Lever, Capper-Ketcham, and supplemental acts----- 7, 662, 936

Forest Service:

Payments to States under Clarke-McNary Act—

(a) Cooperative protection of State and private timberlands against fire (exclusive of \$62,825 for forest-taxation and timber-insurance studies, shown under "General activities" in Table 1)----- 1, 335, 675

(b) Cooperative distribution of forest-planting stock----- 82, 950

Payments to States and Territories from national-forest receipts for benefit of county roads and schools----- 1, 605, 883

Bureau of Public Roads:

Payments to State highway departments for road construction under the Federal-aid road act and supplemental acts (exclusive of \$505,909 for highway research and service activities, shown under "General activities" in Table 1)----- ¹ 77, 386, 283

Total payments to States----- 92, 408, 727

(2) ROAD CONSTRUCTION

(a) Under Federal-aid road act and supplemental acts:

Forest Service—

Construction of forest roads and trails----- 7, 966, 000

Bureau of Public Roads—

Payments to State highway departments for Federal-aid road construction (including \$1,505,420 for administrative expenses but exclusive of \$505,909 for highway research and service activities, the latter being shown under "General activities" in Table 1)--- ¹ 77, 386, 283

Total, Federal-aid road act (exclusive of highway research and service activities)----- 85, 352, 283

(b) Under Forest Service appropriations:

Construction of roads and trails, under "General expenses" fund----- 495, 000

Construction of roads and trails for States (national-forest receipts fund)----- 503, 094

Construction of roads and trails, under "Cooperative work" fund (contributions from private cooperators)--- 1, 018, 202

¹ Included in both of above groups.

(c) Under special appropriations administered by Bureau of Public Roads:

Mount Vernon Memorial Highway-----	\$1, 109, 590
Restoration of roads and bridges damaged by floods in Vermont, New Hampshire, and Kentucky-----	1, 530, 559
Restoration of roads and bridges damaged by floods in Missouri, Mississippi, Louisiana, and Arkansas-----	341, 703
Restoration of roads and bridges damaged by floods in Alabama-----	293
Total road construction-----	90, 350, 724

TABLE 2.—Expenditures classified by types of activity

Type of activity	General activities (all objects except payments to States and road construc- tion)		Payments to States (exclu- sive of Fed- eral-aid road funds)	Road con- struction (in- cluding Fed- eral-aid road funds)	Total	
	Amount	Per cent			Amount	Per cent
Research-----	\$15, 730, 363	¹ 21. 7	² \$4, 335, 000	-----	\$20, 065, 363	11. 3
Extension-----	2, 657, 671	3. 6	³ 7, 662, 936	-----	10, 320, 607	5. 8
Eradication or control of crop and animal pests-----	⁴ 17, 132, 943	23. 6	-----	-----	17, 132, 943	9. 6
Service activities-----	26, 046, 176	35. 9	⁵ 3, 024, 508	-----	29, 070, 684	16. 3
Regulatory work-----	11, 021, 607	15. 2	(⁶)	⁷ \$90, 350, 724	11, 021, 607	6. 2
Road construction-----	-----	-----	(⁶)	⁷ \$90, 350, 724	90, 350, 724	50. 8
Total-----	72, 588, 760	100. 0	⁷ 15, 022, 444	90, 350, 724	177, 961, 928 (Grand total)	100. 0
Percentage of grand total-----	40. 8	-----	8. 4	50. 8	100. 0	-----

¹ 8.8 per cent of grand total.
² Payments to State agricultural experiment stations and to Hawaii under Hatch, Adams, and Purnell Acts.
³ Payments to State agricultural colleges and to Hawaii under Smith-Lever, Capper-Ketcham, and supplemental acts.
⁴ Including \$5,071,000 paid to livestock owners as Federal indemnities for animals destroyed in connection with tuberculosis eradication, and \$4,093,617 for control operations against the Mediterranean fruit fly.
⁵ \$1,335,675 for cooperation with States in forest-fire protection, and \$82,950 for cooperation with States in the distribution of forest-planting stock, under Clarke-McNary Act; and \$1,605,883 for payments to States and Territories from national-forest receipts funds for benefit of county roads and schools.
⁶ \$77,386,283, paid to State highway departments for Federal-aid roads, included under column "Road construction."
⁷ See tabulation, "Payments to States and Road Expenditures."

Income From Department's Activities, Fiscal Year 1930

Incident to the department's work during the fiscal year 1930, receipts totaling \$15,245,327 were paid into the Treasury, and fines were imposed and judgments recovered by the courts amounting to \$119,702, in connection with the enforcement of regulatory laws, as follows:

INCOME FROM RECEIPTS AND FINES

Receipts:

(1) Deposited to credit of miscellaneous receipts fund—		
From business on the national forests----	\$6, 751, 553	
Contributions from private cooperators, appropriated as a special fund for road and trail construction, fire prevention and suppression, brush disposal, and investigative work on national-forest and privately owned lands -----	1, 775, 595	
From other sources-----	1, 232, 708	
		<hr/>
		\$9, 759, 856
(2) Deposited to credit of applicable funds of department—		
Fees collected for classifying cotton, deposited to credit of revolving fund for conducting that work-----	350, 905	
Seed loan collections-----	4, 371, 069	
Reimbursement to various department appropriations for expenditures made therefrom -----	763, 497	
		<hr/>
		5, 485, 471
		<hr/>
Total receipts -----		15, 245, 327
Fines: Fines imposed and judgments recovered by the courts in connection with violations of statutes intrusted to department for enforcement-----		
		<hr/>
		119, 702
		<hr/>
Total income from activities of Department of Agriculture-----		15, 365, 029



7984

REPORT OF THE CHIEF OF THE BUREAU OF AGRICULTURAL ECONOMICS

AGRICULTURE
U. S. DEPARTMENT OF AGRICULTURE

UNITED STATES DEPARTMENT OF AGRICULTURE,
BUREAU OF AGRICULTURAL ECONOMICS,
Washington, D. C., September 26, 1930.

SIR: I transmit herewith a report of the work of the Bureau of Agricultural Economics for the fiscal year ended June 30, 1930.

Respectfully,

NILS A. OLSEN,
Chief of Bureau.

Hon. ARTHUR M. HYDE,
Secretary of Agriculture.

With agriculture continuing to face critical economic difficulties, the resources of the bureau during the past year have been put to maximum use in meeting the demands for economic service and information. The regularly issued reports have been supplemented with numerous special inquiries; the economic research has been directed in large measure to emergencies of one kind or another; and the general information and inspection services have been amplified wherever possible.

Agriculture the world over is passing through a critical period. Expanding crop areas, revolutionary changes in production technic and mounting agricultural surpluses have been paralleled by business depression, impairment of markets, and declining prices of agricultural products. Special effort, therefore, has been made to evaluate the tendencies in competition and demand and provide a better basis for essential adjustments in our agriculture. The analysis of price trends has been strengthened and the long-time phases of the agricultural outlook have received increasing attention. Measures have been initiated to focus, by type-of-farming regions, the farm management researches of the bureau upon the organization and operation of farms. And in the studies of land utilization special effort has been made to determine the best use for submarginal agricultural lands.

A constructive forward step in broadening our knowledge of the foreign competition our farmers must face was taken by Congress in the last session in the enactment of the foreign agricultural service act. Under the provisions of this measure a foreign agricultural service division has been created in the bureau and outposts of American agriculture are now being stationed in the important competing and consuming regions of the world to report

currently on developments affecting the foreign outlets for our products. In the development of this service there will be the closest coordination with the foreign offices and activities of the Departments of State and Commerce.

The activities of the bureau are being materially broadened as a result of several additional pieces of legislation enacted during the last session of Congress. Under an act authorizing the Secretary of Agriculture to conduct investigations of cotton ginning an experimental cotton-ginning plant will be built and operated by the Bureau of Public Roads and the Bureau of Agricultural Economics, to study the effect of various ginning methods and practices upon the quality of the lint. The perishable agricultural commodities act, also enacted by the last Congress, provides for the licensing of commission merchants and others engaged in the buying and selling of fresh fruits and vegetables, and aims to prevent unfair and fraudulent practices in the handling of these products. A special organization is being provided to administer this far-reaching piece of legislation.

Tobacco is a major commodity that hitherto has not received the attention that is warranted by its commercial value. To overcome this shortcoming a tobacco section was established in 1929. This section administers the tobacco stocks and standards act, passed during the preceding session of Congress which requires quarterly reports of tobacco stocks by types and groups of grades. A tobacco inspection service has been inaugurated and other services are being developed in this commodity section.

During the last year a new Federal agency, the Federal Farm Board, was created by Congress to assist in solving the economic problems of agriculture. The activities of the Federal Farm Board are primarily in the field of action, but obviously the board must have the necessary facts upon which to base its conclusions and policies. A primary function of this bureau is to collect and interpret economic data. Its energies and resources have been mobilized accordingly during the past year with the view to providing timely and adequate information on emergency and other phases of the agricultural situation.

DIVISION OF FARM MANAGEMENT AND COSTS

C. L. HOLMES, *in Charge*

Although the work of the Division of Farm Management and Costs is concerned primarily with the economic problems arising from the organization and operation of individual farms, it is necessary also to study agriculture in its broad, collective aspect, its regional development, and the causes and trends of such development. Results of these broad studies make it possible to point out the adjustments that are necessary in order to meet changing economic conditions.

On the individual farm economy side, the division is concerned with the problems of determining the use to which the farmer shall put his resources in terms of cropping programs and livestock systems. It points out the best and most efficient financial and technical organization of agricultural business units and the most efficient methods to be followed in production programs. It is concerned

with studying the efficiency of agricultural production, and the price outlook as it affects the farmer's production program, both from a long-time point of view and from the point of view of year-to-year modification.

TYPES OF FARMING

Data from the last three census reports were mapped and analyzed, and a publication entitled "Shifts in Farming in the United States" was issued. A manuscript dealing with the types of farming as determined by the distribution of crops was practically completed. These maps and their analyses portray changes in the agriculture of the different areas and form a basis for further studies of the reasons for the systems of farming now followed in various areas.

With the completion of work in the States of Michigan, Texas, Minnesota, and Nebraska, a detailed analysis of types of farming has been completed in nine States. These detailed studies have furnished a basis for farm-management programs and have been used in interpreting the National Agricultural Outlook Report in terms of local conditions.

A beginning was made in analyzing local and regional conditions with respect to the reasons for the economic advantages of specified crops. An analysis of factors that determine the wheat acreage under various local and regional conditions is under way. This analysis correlates such factors as growing season, soil, topography, and rainfall with the degree of intensity of wheat production in the agriculture of various areas. This necessarily involves consideration of the economic adaptability of other enterprises.

FARMERS' RESPONSE TO PRICE CHANGES

A study was inaugurated to determine the nature of the causes of shifts made by farmers in their production programs. An understanding of these causes is necessary in forecasting future supplies and in measuring market prospects for particular commodities. Such an analysis involves a determination of the changes that farmers are likely to make as a result of changes in prices and other factors. Particular attention was given to an analysis of factors affecting the flax acreage, both for the United States and for the four important flax States. A manuscript was prepared analyzing the situation and explaining the various factors that are associated with or that determine variations from time to time in the flax acreage.

RANGE-LIVESTOCK PRODUCTION

Studies designed to determine and outline methods of range cattle and sheep production and of ranch organization for each of the important range-livestock producing districts were continued in co-operation with the Bureau of Animal Industry and State agencies. The information collected has been carried back to the ranchman along with outlook material in order that he may conduct his operations to best advantage. Manuscripts were prepared covering research conducted in the Edwards Plateau of Texas, in the Stamford area of Texas, and in North Dakota and South Dakota. Work was continued in Montana and in the North Park and Saratoga Valley districts of Colorado and Wyoming.

In Arizona and New Mexico the study to determine the importance of the various factors affecting range sheep and wool production, range goat and mohair production, and practical modifications that will increase the ranchman's net returns, was continued.

In Montana a study was inaugurated to determine the causes of the wide variations in the number of range sheep and the organization and management of range-sheep production. The main object of this project is to determine the specific forces and conditions that have been shaping the course of the range-sheep enterprise since the World War, with a view of determining probable future developments.

FARM POWER

A study of the utilization and cost of power on farms was started in cooperation with the Bureaus of Public Roads and Animal Industry and 10 State agricultural experiment stations in the central Corn Belt and Cotton Belt States.

The usefulness of both mechanical and animal power has greatly increased through the successful development and adoption of general-purpose tractors, and multiple hitches for horses, improvements in motor trucks and in public roads. The information gathered will throw light on many economic, engineering, and horse-husbandry questions, such as the effect of the use of different forms of power on the organization and operation of farms, labor, and equipment, tendency toward use of mechanical power equipment; efficiency of operations on various crops with tractors of different designs and with various sizes of teams, influence of the motor truck on hauling operations, and the effect of various units of animal and mechanical power on timeliness of operation and size of business.

THE APPLE INDUSTRY

Statistics showing trends in planting of various varieties in the different apple areas were analyzed further, particular attention being given to localized conditions and changes in both commercial and farm orchards. These facts for the State of New York were published by Cornell University in connection with a State project on orchard management in western New York. It is expected that other States will make similar use of the statistics in connection with their local farm-management problems. A report containing tables and charts and bringing together all available statistics and information on the apple industry was published.

In cooperation with State agencies, a manuscript was completed entitled "Marketing Apples in the Cumberland-Shenandoah Area." This manuscript points out important problems confronting the growers in the marketing of the varieties and grades of apples that are produced in that section. It throws light on the future expectations of production and distribution of the various varieties. A study of the place of orcharding in farming systems in the Cumberland-Shenandoah area was also continued. There the principal objective was to determine what constitutes good orchard management with respect to production and marketing, the economic combinations of other enterprises with the orchard, and the size of business suitable for specified incomes.

THE EASTERN GRAPE SITUATION

An economic study of the eastern grape industry was continued in cooperation with the agricultural experiment stations of Arkansas, New York, Michigan, and Pennsylvania. This study was undertaken for the purpose of determining what growers could do to enlarge their farm returns. Information was collected on the condition of vineyards, recent plantings, removals, and the care being given to the vines. Various cultural practices were studied and analyzed in relation to the quality of grapes produced, cost, and prices received for the grapes. Results thus far obtained were placed before the farmers of Pennsylvania and New York at meetings held for this purpose.

THE PECAN INDUSTRY

An economic study of the pecan industry, which was undertaken at the request of the National Pecan Growers' Association, was continued in cooperation with State agricultural colleges and experiment stations. Information was obtained and prepared for publication relative to the practices and costs involved in the development of a pecan orchard to bearing age and in the cost of producing nuts thereafter. This phase of the work has been coordinated with other phases of a study of pecans made in this bureau. The work of the Division of Farm Management and Costs is to determine the reasons for success or failure in the development and management of pecan groves and to show the practicability and necessity of effecting economies in production in view of marketing conditions and production potentialities of the industry.

BROOMCORN PRODUCTION

As the result of a cooperative project with the Bureau of Plant Industry, the agricultural colleges and experiment stations of the States of Illinois, Oklahoma, and Kansas, the economic and agronomic study of the broomcorn industry was continued. Although the broomcorn industry is of minor importance nationally, the demand for broomcorn has a direct bearing upon the economic welfare of groups of farmers in the above States.

The study was planned to determine the place of broomcorn in the system of farming in each of the important districts under different price conditions and to set forth the most efficient methods of growing and harvesting the crop. A manuscript was prepared for publication as a farmers' bulletin, dealing with the production and handling of broomcorn, and another for publication as a technical bulletin giving the detailed analyses of the results of the study.

RETURNS TO STRAWBERRY GROWERS

An economic study of the strawberry industry in 20 districts of 11 Southern and Eastern States was continued in cooperation with State agricultural colleges and experiment stations. A mimeographed report was published which showed total production costs and common practices for handling strawberry fields, distribution by important varieties, daily prices to growers by grade and variety, estimated average yields for the different years of the life of the planting, and the place of strawberries in the farming systems of the different districts.

CITRUS FARMING IN FLORIDA

A study of the citrus industry in Florida was begun in the early spring of 1930 in cooperation with the University of Florida. Data have been obtained in the Winter Haven section and in Lake and Orange Counties. The main object of this study was to measure the gross and net income from citrus farming and the factors influencing income. Particular attention was given to the incomes and expenditures of absentee owners, and to a study of the relative efficiency of operation for small groves when cared for by the owner and when cared for by a specialized caretaker who cares for several small acreages owned by different individuals. The economic relationship of the citrus industry to the demand and market outlet for the product as related to the natural and economic conditions of the area was given attention.

DAIRY-FARM MANAGEMENT IN VIRGINIA

A 3-year study, in cooperation with the Virginia Agricultural Experiment Station, of the factors affecting earnings of dairymen near Richmond, Va., was completed. Conservation of manure, the inclusion of legumes in the cropping system, the development of pastures and soiling crops, and judicious feeding of high-producing cows were found to be the essentials to successful dairying in this limited district. Producers in this district of highly specialized dairy farms have high operating costs; consequently, high average production per cow, together with a uniform supply of marketable milk, is essential to successful dairying. This high standard of production can be attained through the production of crops with high feeding value and the distribution of the freshening of cows so as to secure year-round milk production.

EARLY-POTATO FARMING

In cooperation with the Virginia Polytechnic Institute, this bureau inaugurated a study to determine reasons for the unstable volume of early-potato production and extreme fluctuation of prices in relation to the prevailing system of farm organization and management of the section and of the sources and supplies of credit.

Preliminary results of the first year's work indicate that the problem of the territory is largely one of adjusting production to demand and of efficiency of production of the potato crop. No outstanding opportunities appear for substituting other crops to any great extent. The opportunity for expanding poultry, hogs, and dairy beyond local needs seems to be very limited. The study is being continued for the purpose of working out alternative forms of farm organization that will minimize the wide fluctuation in the potato acreage and result in a more efficient and stabilized production.

COTTON, PEANUT, AND HOG FARMING IN GEORGIA AND ALABAMA

Cotton, peanuts, and hogs are sources of cash income in a large section of southeastern Alabama and southwestern Georgia. A two years' field study of the economics of production in this section, conducted in cooperation with the Georgia State College of Agri-

culture and the Alabama Experiment Station, was completed, and an analysis of the data is in progress.

This study demonstrated that the 1-plow family farm can maintain only a low standard of living unless the family income is supplemented from some outside occupation or the farm is operated with an intensity of cultivation which is not typical of the section. The analysis also indicates the division of income and expense between the operator and croppers to show the minimum number of plows per farm which can be reasonably expected to yield the operator a satisfactory standard of living. Farm organizations with various combinations of cotton and peanuts (the peanuts being marketed as a cash crop or through hogs) are being outlined, with their normal net income under stated price conditions, and the effect of changing price relationships upon gross and net income.

INFLUENCE OF WINTER LEGUMES ON CROP PRODUCTION

In cooperation with the Bureau of Plant Industry a study was made of the use of winter legumes in various systems of farming in the States of Georgia, Alabama, North Carolina, and South Carolina. The benefits derived by farmers from the use of winter legumes are so pronounced and of such an economic importance to southern growers that the project was expanded. The results of the previous year's study indicate that where the crops were plowed down for corn the yield is increased from 5 to 30 bushels per acre in average seasons.

The past year's work has shown that under certain conditions of climate, soil, and fertilization the beneficial results from plowing under winter legumes were reduced to a minimum. Particular attention was given to determining methods of procedure which will bring the best results from the use of winter legumes. Attention was given to the time and manner of sowing and of turning under the legumes, to the inoculation of the seed or soil, the use of fertilizer, the date of planting the following crop, and the time of planting after the legume was plowed under.

ORGANIZATION AND MANAGEMENT OF COTTON PLANTATIONS

In cooperation with the Arkansas Agricultural Experiment Station a study was undertaken for the purpose of working out improvements in the organization and management of cotton plantations, with special reference to the utilization of labor and farm power. The study will be confined to cotton plantations of about 500 cultivated acres or more. Data will be collected from the plantation accounts, and these data will be analyzed for the purpose of finding out the advantages and disadvantages of the different forms of labor, equipment, and power units.

EUROPEAN CORN BORER

A study to determine the most successful systems of farm organization and management under corn-borer conditions was continued in cooperation with the Indiana Agricultural Experiment Station. A similar study was begun with the Michigan State College of Agriculture in the more heavily infested localities of Michigan. The

continued advance of the borer toward the central Corn Belt makes these studies of particular importance. Changes in crop rotations, livestock combinations, types of equipment, and general farm practices and their effect on soil fertility, control of the corn borer, and farm returns are considered.

Study of the possibility of substituting other crops for corn in the Corn Belt was continued. The importance of corn in the crop and livestock systems found in the Corn Belt and its relatively greater value as a feed or cash crop and in the use of a large amount of profitable labor indicate the extent to which farms should go to retain corn in the rotation. The general relation of the present supply of cash crops, such as wheat, rye, sugar beets, canning crops, and potatoes and the effect which their substitution for a part of the present corn acreage would have on prices have been considered. The possible cost of controlling the borer under different conditions and the extent to which farmers can afford to rely on control measures at increased production costs of corn have been studied and information made available.

CORN-HARVESTING METHODS

A study of the methods and costs of harvesting corn was started in cooperation with the Illinois Agricultural Experiment Station to determine the most feasible and economic farm practice both under present conditions and under conditions of possible corn-borer infestation. The relative costs and physical requirements of hand husking, machine picking, cutting for silage both with field and stationary cutter, and cutting for fodder were determined. Records kept on the harvesting operations in the fall of 1929, and other detailed records obtained in previous years were used in the analysis. Husking from the standing stalks accounts for nearly 90 per cent of the corn harvested. Until the last few years machine picking was of little importance. It was found that whereas the average labor in hand picking amounted to about 5.5 hours per acre, only 2.7 hours were used per acre with the 1-row picker and 2.2 hours with the 2-row machines. Field silage cutters are common in the dairy district in northern Illinois. Although the rate of cutting was lower with the field cutter than with the stationary cutter, less labor was used per ton of silage, and the number of men required was considerably lower.

LARGE-SCALE FARMING

Because of the continued widespread interest in large-scale farming the bureau has expanded its study of large-scale farms. Approximately 22,000 questionnaires were mailed recently to individuals who, in the opinion of the crop reporters and bankers suggesting them, were operating "large-scale" farms. As a result of this investigation it is hoped that the majority of large-scale farms in the United States may be located and classified according to size and to type of farming; and that the organization, operation, and management of these farms may be analyzed in such a way as to be of benefit to the individuals reporting and to others interested in the subject.

Current studies indicate that some of the present large-scale farming organizations can not be looked upon as permanent. There are

other large-scale farming organizations, however, which are sound, and it is expected that many large-scale farms and farming corporations will be established in the next few years. The present study is designed to determine the conditions and the forms of organization and management under which such ventures are likely to be permanent and successful.

SWEETCLOVER IN THE CORN BELT

An economic study of sweetclover on Corn Belt farms, conducted in cooperation with the Bureau of Plant Industry and several Corn Belt States, was completed. Records of utilization practices, cost of seeding, carrying capacity of sweetclover pasture, and increased yield of crops following sweetclover were obtained from more than 200 farms. These data have been summarized and prepared for publication.

The relative cheapness of seed, the ease with which it may be fitted into established cropping systems, and its outstanding value as a pasture and soil-improving crop have made sweetclover the most valuable leguminous crop in the Corn Belt. It was found that the first year's growth may be grazed for about two months in the fall and during this time will carry the equivalent of 1 to 1.5 mature animals to the acre. The second-year crop is usually pastured from about May 1 to August 20, and if grazed to capacity will carry the equivalent of 2 to 3 mature animals to the acre over this period. Data obtained indicate that on land on which long-continued cropping to corn and small grain has reduced yields to a low level a single crop of sweetclover plowed under will frequently increase the yield of the succeeding crop of corn or wheat from 25 to 100 per cent.

FARMING IN THE APPALACHIAN HILL LANDS

Studies of farming under adverse conditions found in the Appalachian Plateau country throw considerable light on the inadequacy of the income from farming alone to support the farm family. Figures from 503 farm families show that average incomes from the sale of farm products after farm expenses were paid amounted to \$272; income from outside work of the farmer to \$185; and other miscellaneous income to \$121. Only 69 of the 503 families depended entirely upon the sales of farm products for their family living expenditures and their savings, and 434 of them depended to a greater or less extent upon supplementary incomes. Studies carried on in cooperation with the experiment stations in Kentucky and Ohio thoroughly analyzed farm organizations in several counties and pointed out means of improving the farming operations.

WHEAT FARMING IN EASTERN WASHINGTON AND NORTHERN IDAHO

A large area of eastern Washington and northern Idaho represents one of the most important dry-farming wheat sections in the United States. In this section wheat has been grown for a great many years, and recently it has become a serious problem to maintain wheat yields. Such a problem involves a decided change in the system of farming. In cooperation with the Washington Agricultural Experiment Station and the University of Idaho a study

was made primarily designed to determine the enterprises and the types of farming best adapted to the physical and market conditions of the district. The results have been prepared for publication. Systems of farming were developed which appear to be best suited for increasing incomes under conditions prevailing, and plans were set forth which are designed to meet changing conditions. These farming systems involve the more general use of peas and sweet-clover in the crop rotation for the purpose of building up the productivity of the soil. Such a system eliminates a considerable proportion of the summer fallow and appears to offer opportunity for increasing profits through increased yields and through the greater utilization of the land each year.

BULK HANDLING VERSUS SACK HANDLING OF GRAIN

In cooperation with the agricultural experiment stations of Washington, Idaho, and Oregon, a study was begun to determine the relative economy of bulking and sacking grain on the farm. Farmers' experiences in shifting from sack to bulk handling are being studied. Particular attention is given to comparative labor and equipment costs in harvesting and handling the grain and to the efficiency of operating under each method.

In changing from sack to bulk handling, the amount, cost, and specifications of field and hauling equipment and of farm storage are vital factors. These are being studied for various sets of conditions relating to size of business, topography of fields, and distance from local market. Widespread interest among farmers in the practicability of making the shift and how to go about it indicates the timeliness of the project.

POULTRY FARMING

In cooperation with the Agricultural College of Utah, a study was undertaken of the economic place of poultry in the organization of Utah farms and the factors that affect the returns received by poultry farmers. Poultry and egg production in Utah has had rapid expansion within recent years, the shipments of high-quality eggs to eastern markets increasing to such an extent that Utah is one of the important sources of receipts in the off-season months.

In this study the amount and costs of land, labor, materials, and equipment used in poultry production are ascertained, as well as the egg-laying performances of flocks and the effect of the expansion of the industry upon farm organizations, for the purpose of indicating for different sets of conditions in the State the most successful poultry-farm organizations. The facts as brought out in this study will also be useful in indicating the most profitable methods of management of farms that have poultry as an important enterprise.

A report was completed consisting mainly of charts, maps, and statistical tables dealing with the economic factors affecting the production, marketing, and prices of poultry and eggs in the United States. This report contains comprehensive statistical data regarding the industry, which will be of use to commercial poultrymen and research and extension poultry specialists throughout the United States.

BETTER SYSTEMS OF FARMING

The project on the development of more profitable farming systems for the Virginia dark-tobacco section was continued in cooperation with the Virginia Extension Service. On the farms on which the recommendations have been made and followed by the farm operator the returns continued well above the returns on other farms where no appreciable change in the system of farming had been made.

In parts of the spring-wheat area the tendency is to reduce wheat acreage. Farming systems are changing gradually to those with less wheat, more feed grains and pasture, and more livestock. In cooperation with the State Experiment Station of North Dakota, farm plans which are the result of carefully made budgets are prepared for the farmers' consideration. The results of each year's operations are compared with the results suggested by the original budgets. In this way data are obtained on profitable farming systems for the area and on the extent to which farmers in this area may make use of economic and technical information.

In southwestern Kansas the acreage of wheat has been increasing rapidly. The widespread use of improved mechanical equipment has lowered the cost of growing wheat, has enlarged the acreage that could be seeded and harvested by one man, and has encouraged the increase of wheat acreage. These developments are requiring adjustments in the farming program. A study undertaken in cooperation with the Kansas State Experiment Station aims to show the most profitable system of farming for the various natural conditions in the district, the economical size of farm unit, the safe degree of specialization in wheat, and conditions under which other crops and livestock will add to farm earnings.

In cooperation with the Oklahoma Agricultural Experiment Station, farm budgets were prepared for representative farms in northwestern Oklahoma. These budgets, which were worked out with the help of individual farmers indicate possibilities of increasing net returns over previous systems. More profitable wheat production was suggested through a more liberal use of alfalfa, sweetclover, cattle, and sheep. The results were presented at farmers' meetings held in the section.

The results of a 2-year study of farm management in Jones County, Miss., in cooperation with the Mississippi Agricultural Experiment Station were prepared for publication. It was shown that in that section successful crop production requires careful soil management and judicious use of fertilizer. The terraced fields are not adapted to the use of large machinery for cotton cultivation. The eradication of the fever tick has improved the opportunity for income from livestock, and the depletion of the timber has made the farmers more dependent on farm production. Plans for the better utilization of the farmers' resources were set forth.

Studies of systems of farming were made also in North Carolina, Tennessee, Minnesota, Wisconsin, Texas, Illinois, and Montana, all in cooperation with State agencies.

SUMMARIES FROM FARM-BUSINESS STUDIES

This division acts as a coordinating agency in the assembling and compiling of specific results from farm-business studies made by this bureau and by State agricultural experiment stations and colleges. Data from each farm-business study are summarized to show the type of farming, average acreage, capital, expenses, and such forms of income as receipts, farm income, labor income, return to capital, family living from the farm, and operator's earnings for each study. During the year data have been summarized for 17,887 farms in 209 localities in 36 States. These records, added to the 71,515 records for which similar data were published in the Yearbook of Agriculture, 1925, bring the total number close to 90,000.

FARM RECORDS, ACCOUNTS, AND BUDGETS

Further progress was made in summarizing farm-production data obtained through farm-account studies carried on in cooperation with State college and experiment stations. This material shows the variations in farming practices in different sections of the United States and variations in materials used in producing crops and livestock, and covers studies made in 38 localities in 18 States.

Forms for obtaining daily records showing man labor, horse work, and fertilizer used in crop production and the man labor, horse work, feeds, and other cost factors used in the production of livestock and livestock products were furnished to a number of State colleges and experiment stations where farm-management studies by means of detailed records are being carried on. Data from these studies show practices worked out by successful farmers, the amount of different cost elements used in crop and livestock production under varying conditions, and provide basic information for farm reorganization and farm budgeting. Interest of farmers in farm records is evidenced by numerous inquiries regarding methods of farm book-keeping and farm accounting which will give them information on which farming plans can be based.

COST OF PRODUCING STAPLE CROPS

Cost-of-production figures for corn, wheat, oats, and cotton, were published as heretofore. The average cost of producing the 1929 corn crop on 4,150 farms was 73 cents per bushel, which was the same as the average figure reported for the 1928 crop. Corn yields reported by these farmers averaged 31 bushels per acre in both years. For wheat, the average 1929 cost reported by 2,898 farmers was \$1.24 per bushel, which also was the same as the average reported for 1928. Average yields reported for both years were 17 bushels per acre. For oats the average 1929 cost reported by 3,081 farmers was 54 cents per bushel, which was 4 cents higher than the average cost reported in 1928. Oat yields on these farms averaged 33 bushels in 1929 and 37 bushels in 1928.

Cotton costs reported by 929 farmers were tabulated by yield groups, since many of the farmers reporting had yields that were much above the average. On 273 of these farms yields varied from 101 to 180 pounds per acre and averaged 147 pounds. For this group the average cost was about 16 cents per pound. On the lower yielding farms, costs were higher, and on the higher yielding farms costs were lower.

The cost figures include charges for labor of the farmer and members of the family and a charge for the use of land on a cash-rental basis.

APPLICATION OF OUTLOOK INFORMATION

The study of the use of outlook information in determining short-time and long-time adjustments in farm organizations was continued. Farmers usually alter their farm organizations to some extent in response to changes in price relationships that have prevailed in the past. Efforts were made by this bureau to demonstrate to farmers, in dollars and cents, the profitableness of making shifts in organizations in the light of probable future price relationships, rather than on past conditions. Losses may be minimized and profits increased if probable future prices are considered in planning the farm business, and by means of budgets of actual farm operations, many farmers were shown the increased returns resulting from planning based upon the outlook.

FARM RETURNS

Voluntary reporters submitted statements of the financial results of operations on their farms during 1929, which are summarized as follows: The average return of 11,805 owner operators for 1929 was \$1,298 from farms averaging 270 acres and representing an investment of \$15,242 at values current on January 1, 1929. Cash receipts from these farms on an average amounted to \$2,669; cash outlay for current operating expenses amounted to \$1,572, leaving a cash balance for the year amounting to \$1,097, in addition to which there was an increase of \$201 in the inventory value of crops, livestock, machinery, and farm supplies. These farms supplied the farm family with food to the value of \$262 as estimated by those farmers reporting the item.

Average cash receipts, average cash outlay for current operating expenses, and the balance between these were larger than the averages for the same items in any of the previous years (1922-1928) in which farmers from the same general list have reported their returns. The net return for 1929 was slightly less than that for 1928, largely because of lower prices for inventory items at the end of the year than at the beginning. Averages obtained in this inquiry addressed to owner operators, however, are considerably above the averages for farms of all sizes and tenure classes computed from the census of 1925 or estimated from mass statistics of production and prices.

ECONOMIC BASIS FOR FERTILIZER EXPERIMENTATION

This division has worked out a method of basing fertilizer experiments on the formula for the law of diminishing returns that makes it possible from a few simple plot experiments to ascertain (1) the quantity of available nitrogen, phosphoric acid, and potash in the soil, (2) the fertilizer analysis that will give the largest return per dollar spent for fertilizer, (3) the quantity of available nitrogen added to the soil by a leguminous crop turned under, and (4) the effect of any course of soil management on the yielding power of the soil.

FEDERAL-PRISON FARMS

Aid was given the United States Department of Justice in working out certain problems connected with the organization and operation of Federal-prison farms.

For the 1,200-acre penitentiary farm near Atlanta, a survey was made and advice given as to the proper location of new barracks and farm buildings, a revision and amplification of the farm equipment, and proper methods of operation.

Aid given to the 2,500-acre Federal road camp near Petersburg, Va., began with the development of a dietary for an initial 600 men as a basis for determining the crop and livestock-product requirements and the productive livestock needed. The dietary was based on the energy, protein, and mineral requirements recommended by the Bureau of Home Economics for farm workers. The quantities of available vegetables and fruits in variety and the livestock products to furnish such of these dietary requirements as practicable from the farm, were determined for each month of the year. These data, together with average yields for the section, furnished a basis for determining crop varieties and acreages.

Estimates of the work stock and machinery needed for operation and the quantities of seeds and fertilizers needed were made, and directions given for planting and the use of fertilizer.

Assistance was received from the Bureaus of Public Roads, Chemistry and Soils, Plant Industry, Animal Industry, and Dairy Industry on numerous items relating to this work.

DIVISION OF CROP AND LIVESTOCK ESTIMATES

W. F. CALLANDER, *in Charge*

The outstanding accomplishments of the Division of Crop and Livestock Estimates have been (1) the development and improvement of forecasts and estimates covering more than 20 vegetable crops; (2) the preparation for the Bureau of the Census of average farm prices by counties for 156 crops and livestock products for the 1929 marketing season, and inventory values of 30 livestock items as of April 1, 1930; (3) the completion of tentative estimates of farm income by States for the 5-year period, 1924-1928, inclusive, covering 78 different crops and 14 items of livestock and livestock products; and (4) statistical improvement in the technic of crop forecasting.

Research work on methods of forecasting from sample data has been pushed, particularly in developing accurate methods of forecasting yields per acre. The method used for many years in forecasting yields per acre on the basis of straight-line relationships between condition and final yield in previous years has been largely discarded or modified. Extensive studies to determine the effect of weather on yields have been conducted, and the results obtained will make it possible to estimate yields more accurately.

The technical staff of the division includes 100 men, of whom 12 are in Washington and 88 in the field. All of these men have had training in statistical methods. In addition, schools of instruction have been conducted in Washington each winter, in which several weeks of intensive training in the application of modern statistical methods to crop-forecasting problems has been given.

The State of Georgia was added to the list of States in which the crop-reporting work is carried on in cooperation with State agencies. At the close of the year cooperative agreements were in effect in 37 States; 31 being with State departments or boards of agriculture and 6 with State colleges of agriculture.

In addition to the regular reports on all crops and classes of livestock, many special reports have been made. One of the most important was the report showing capacity of grain elevators and mills in practically all of the important States west of the Mississippi River.

FRUIT AND TRUCK-CROP ESTIMATING DEVELOPMENTS

Increased funds became available July 1, 1929, for the improvement of commercial truck and canning crop estimates, covering 20 commodities. Because of their perishable nature, the ordinary short growing and marketing season, and the quick succession with which products from widely scattered areas of commercial production appear in the market, constant field contact with each active area is imperative during its season of production and movement. Four new men were appointed and assigned to specific areas; one to the south Atlantic group of States, from North Carolina to Florida another to the Eastern Shore; one to the important east north central canning area; another to the three Pacific Northwestern States. A large share of the time of another estimator was devoted to the work in Alabama and Mississippi. Additional funds were furnished the State offices in the West North Central States and arrangements made for carrying the important work along. Similarly in Arizona, New Mexico, Utah and Nevada, Colorado, Louisiana, Arkansas, New York, New Jersey, and New England, arrangements were made with the State offices for conducting the necessary work.

Interest in the commercial truck and canning crop production reports has grown tremendously as these crops have expanded in volume and value in the older areas, as well as in new centers of population.

Probably the most significant change in the reporting service, made possible by the additional funds, has been the transition from collective reports on groups of commodities to reports on single commodities, in which are included practically all the current statistical and commentary information assembled on the crops. These refinements have improved the usefulness of the reports and have permitted the more efficient and economic distribution of current data to interested persons. During the year, 540,000 copies of reports were mailed, as compared with 375,000 copies in the previous fiscal year. More effective use of the estimates has been obtained through prompt release to the press, by transmitting timely and interesting crop details by leased wire to field offices of the market-news service, and through the review and analysis of the material for radio presentation.

The most important developments in this work with respect to the canning crops have been the improved methods of compiling and analyzing canners' reports, the reorganization of inquiries, and the addition of new types of information. The accomplishments thus far involve only vegetable crops, but work has been begun on fruits and berries. Limited surveys have been undertaken in the Pacific Northwest, in Michigan, and a few other important areas. The

data compiled from these, with the more comprehensive details that will be available in the 1930 census returns, will provide the basis for additional reports on the fruit crops and their commercial utilization.

FARM-PRICE REPORTS

During the year the division collected by counties the average farm prices of 156 crops and livestock products for the 1929 marketing season and inventory values of 30 livestock items as of April 1, 1930, for the use of the Bureau of the Census in evaluating their current enumeration of agricultural production.

The method of procedure used in collecting per unit values for the 1930 agricultural enumeration is briefly summarized below.

Prices were collected monthly by this division during the 1929 marketing season and were averaged, by crop-reporting districts, for 31 of the principal crops and livestock products. These district prices, by months, were weighted by the usual rate of marketing for a given State to obtain a weighted price for the crop year. Prices of early season crops and check data on livestock products sold in 1929 were compiled, by districts, from the division's regular December 1 and January 1 price inquiries, and a special questionnaire sent to all voluntary reporters during the latter part of the year. The same list of correspondents was again circularized on April 1, 1930, for inventory values of livestock according to the age and sex classification as of that date. Prices received by growers for special crops, such as peanuts, dry edible beans, broomcorn, and grain sorghums, were collected, by counties, from lists of commercial growers and dealers.

Prices of fruits and berries in commercial areas of production were obtained through the field offices in 42 different States. The field men also collected prices of 47 miscellaneous crops such as emmer, spelt, hemp, and ginseng.

In recognition of the desirability for individual price estimates for areas smaller than the crop-reporting districts, every effort was made to obtain county prices for agricultural commodities of general importance and especially for crops of localized production.

In addition to the census price project, the regular routine work of preparing monthly reports on prices paid farmers for 45 commodities, quarterly reports on retail prices of 170 articles farmers buy, monthly summaries of wholesale prices of miscellaneous commodities, quarterly reports on wages paid hired farm labor, and crop-year averages of prices for the farm-income study of this bureau was carried on as usual.

FARM VALUE, GROSS INCOME, AND CASH INCOME FROM FARM PRODUCTION

Tentative estimates of farm income by States were completed for the 5-year period 1924 to 1928, inclusive. Estimates for 78 crops and for 14 items of livestock and livestock products were included. In general, the estimates were formulated to treat the farmers of each State as one unit. Farm income, according to this method, consists of the income from farm commodities sold from the farm for shipment out of the State or for use in the industries either within or out of the State.

Total farm value of crop production and livestock production, gross income and cash income from crops, from livestock, and from crops and livestock combined; gross value, gross income, and cash income, for the United States, by commodities; and estimates of gross income for 1928 by commodities and by States have been published. Details of the estimates by commodities and by States, together with production, disposition, and price data used, 1924 to 1928, were published in mimeographed form.

HISTORICAL REVISION OF CROP ACREAGE AND PRODUCTION, AND ESTIMATES OF LIVESTOCK NUMBERS

Progress was made upon the revision of the historical data on acreage and production of crops and upon estimates of livestock numbers, which is being conducted in cooperation with the Division of Statistical and Historical Research. The compilation of assessors' and other enumerations bearing upon this subject was completed, and data available in the bureau's records were compiled. An analysis of census data, wording of inquiries, and possible effect of time of enumeration was made also. This project has now entered the final phase of the determination of tentative and final estimates of acreage, yield per acre, and production of crops and of numbers of livestock on farms. Tentative estimates for a number of important States were completed and tested by correlation with historical price series.

LIVESTOCK ESTIMATES

Distinct progress has been made in working out new methods of obtaining information as to changes in livestock numbers and production which will further improve the accuracy of various livestock estimates.

The most important contribution to the industry was the completion and publication of tentative estimates of livestock production by States for the years 1924 to 1929. These estimates include balance sheets showing by States the items of annual increase and decrease in cattle, hog, and sheep numbers for each of these years; the net quantity of production of each species in pounds of live weight and the value of this production by States; the gross income and the cash income from each species.

Progress has been made in revising the estimates of livestock numbers on farms January 1 from 1867 to 1919, to give a comparable series of numbers over the whole period. Much information covering annual assessments of livestock by States has been obtained. Effort is made to obtain and organize all available information on marketings and slaughter by States and areas and to assemble information as to production methods that will throw light on changes in livestock numbers.

Detailed statistical studies have been made to determine the factors that affect changes in hog production and in seasonal market distribution of hogs for the different States of the Corn Belt and for areas outside the Corn Belt. The object of this work is to furnish a basis for actual numerical estimates of the pig crops by States and for forecasting the market supplies and seasonal distribution of these supplies.

Further improvements in the methods of obtaining sample information showing changes in livestock numbers and production were made. To secure a measure of memory bias and some indication of intentional bias in livestock sample data, records for a large number of farms for consecutive years are secured by matching reports. The indications of changes in numbers on these identical farms give a measure of bias, where historical questions are asked, and are in themselves valuable evidence of changes in total numbers.

A cooperative agreement between the Bureau of the Census and this bureau covering sheep enumeration in the Western States was entered into in order to obtain more complete data on range sheep. The State statisticians of this division were appointed special agents of the census, and as such prepared lists of all sheep owners in their States and will assist the census supervisors in checking these names against enumeration lists and in securing missing reports.

Since the principal value to producers of statistical information as to livestock numbers and supplies is in the indications that these give as to future conditions in the industry, more and more attention is being given to study of methods for interpreting these figures. Such studies will make the outlook reports on livestock increasingly dependable.

POULTRY REPORTS

The regular monthly inquiry to crop reporters concerning the numbers of chickens on hand in their own flocks, and number of eggs laid on the first day of each month has been continued, as well as special inquiries on various matters of concern to the poultry industry. Studies carried on during the last two years have resulted in the preparation of tentative estimates covering numbers and value of chickens on farms on January 1, 1920-1930, by grand divisions; numbers and value of chickens on farms January 1, 1925-1930, by States; numbers and value of chickens raised, consumed on farms, and sold, 1924-1929, by States; number and value of eggs produced on farms, used for hatching, consumed on farms and sold, 1924-1929, by States; and other information. The data on poultry and poultry products are not yet on a par with those for other important commodities.

MILK AND DAIRY REPORTS

Additional funds became available in July, 1930, for collecting statistics on milk production, and work was started on the development of a program that would best meet the needs of 5,000,000 farmers and of the organizations marketing dairy products. Numerous conferences have been held with producers' organizations, State dairy commissioners, and others interested in dairy statistics.

According to present plans the annual reports will summarize available information as to the number of milk cows on farms, numbers of heifers and heifer calves being saved for milk production, plans of producers in regard to increases or decreases in the size of their herds, and other information needed in connection with outlook reports. The monthly reports will include details regarding the condition of pastures, the quantity of grain being fed to milk cows, the production of milk per cow on the first of each month, the receipts of old dairy cows and dairy calves in stockyards, changes in

the time of freshening, and such other information as is needed currently by producers and producers' organizations for properly adjusting their feeding, breeding, and marketing programs.

Preliminary studies have shown substantial differences of opinion between producers' organizations as to the causes for changes in milk and butter production and a corresponding difference of opinion as to the adjustments that should be made. This division will, therefore, endeavor to obtain such current and basic information as is needed to explain the causes of such changes in production as may hereafter be apparent.

Questions regarding the number of cows milked, total number of milk cows and the daily production of milk, etc. were added to the cards distributed to farmers by rural mail carriers in June, 1930. About 100,000 cards have already been returned. Similar information is being collected monthly from 20,000 crop correspondents, and a new list of dairy reporters is now being established for obtaining a more detailed record of monthly production and deliveries of milk and butterfat, of grain being fed, of calves allowed to suck, and of changes in time of freshening.

Progress has been made in calculating the quantity of milk produced and sold by farmers of each State and in calculating the gross income and cash income which farmers obtain from milk production. Tentative estimates for the five years, 1924 to 1928, inclusive, have been issued, and work on estimates for 1929 will soon be completed. Work on the month-to-month changes in production has been started, and as the task of estimating the quantity of milk and butterfat used in manufactured products, sold for fluid consumption, and utilized on farms progresses, a more accurate check will be had on the estimates of production.

DIVISION OF COTTON MARKETING

ARTHUR W. PALMER, *in Charge*

The Division of Cotton Marketing is engaged in service and regulatory work, and in research studies, under the authority of the United States cotton futures act of August 11, 1916, as amended; the United States cotton standards act; the act of March 3, 1927, authorizing the Secretary of Agriculture to collect and publish statistics of the grade and staple length of cotton; the act of April 12, 1928, relating to the investigations of new uses of cotton; and the act of April 19, 1930, authorizing the Secretary of Agriculture to erect and operate an experimental ginning plant; and general statutory authority.

REVISION OF STANDARDS

PREPARATION OF LONG-STAPLE COTTON

On May 20, 1929, the Secretary issued a public notice relative to tentative standards for the preparation of long-staple cotton. The tentative preparation types have been widely used by the trade in the United States, as evidenced by the fact that some 655 boxes have been distributed to the public.

REVISED STANDARDS FOR AMERICAN EGYPTIAN COTTON

The revised standards for American Egyptian cotton which were promulgated on April 10, 1929, effective August 1, 1930, were largely used in merchandising the 1929 crop. Experience has demonstrated that the use of intermediate or half grades in the classification of American Egyptian cotton according to the revised standards would be in the interest of more exact determination of quality and more exact and satisfactory adjustments in the settlement of contracts of purchase and sale. Accordingly on July 3, 1930, the Secretary signed an order providing for the use of intermediate-grade designations.

ADDITIONAL STAPLE LENGTH DESIGNATIONS

The additional length designations 29/32 and 31/32 which were promulgated during the preceding fiscal year became fully effective on November 16, 1929. These designations were established at the urgent request of various groups in the industry which pointed out that the elimination of millimeter descriptions in interstate and foreign commerce had made it particularly important that provision be made for more exact length descriptions of cotton shorter than 1 inch.

ENFORCEMENT OF UNITED STATES COTTON FUTURES ACT AND UNITED STATES COTTON STANDARDS ACT

Service and Regulatory Announcements No. 117, containing an account of the proceedings of the International Cotton Standards Conference of 1929 and items relating to the administration of the cotton futures and cotton standards act, was published, and a number of amendments to the regulations were issued.

The fee for classification was reduced from 40 cents to 30 cents per bale for the determination of grade and staple. This action was possible because of the extraordinary increase during the year in the certification work handled by the various boards of cotton examiners.

CLASSIFICATION OF COTTON UNDER THE UNITED STATES COTTON FUTURES ACT

The United States cotton futures act requires that all cotton intended for delivery on futures contracts entered into in accordance with section 5 shall be classified by officers of the department. Boards of cotton examiners were continued at New York, New Orleans, and Houston-Galveston, and an appeal board of review examiners in Washington, D. C.

Additional boards were established at Norfolk, Charleston, and Savannah in order to take care of the southern deliveries provided for by the New York Cotton Exchange.

The volume of classification work far exceeded that of any preceding year in the history of the administration of this statute. During the year total original certifications numbered 917,869 bales, as compared with 446,181 bales in 1929.

Because of the fact that new original representations of the official standards for length of staple became effective on August 1, 1929, it became necessary to restaple all of the certificated stocks at the various futures contract delivery points as of that date.

Collections during the year amounted to \$350,928.67 and disbursements to \$178,890.74. Of the total collections, \$14,188.18 was for loose cotton and the balance for classification fees. A balance of \$324,588.89 for conducting the work for the fiscal year 1931 was in the Treasury on July 1, 1930.

CLASSIFICATION OF COTTON UNDER THE UNITED STATES COTTON STANDARDS ACT

Under the United States cotton standards act any samples of cotton may be submitted to the department for classification, and the various boards of cotton examiners are authorized to perform this service.

Approximately 55,000 bales were classified under this act during the year, and collections amounted to \$22,550.07.

LICENSING OF COTTON CLASSERS

The cotton standards act authorizes the Secretary of Agriculture to issue licenses for grading cotton in accordance with the official cotton standards of the United States. During the fiscal year 143 applicants were examined for licenses; 114 licenses were granted, including 59 renewals. The matter of supervising the classification work of licensees has been particularly stressed, and during the active season a specialist gave his entire time to this work.

Licensing work is assuming a greater importance than ever before in view of the fact that a number of cotton cooperative associations have announced that in the future all of their responsible classification work will be handled only by persons who qualify for licenses under the cotton standards act. At the close of the fiscal year a greatly increased interest was in evidence among classers throughout the South, who hoped to pass the practical test and otherwise meet the requirements necessary to secure licenses. The employment of licensed classers by cooperative associations and the trade generally is doing much to encourage a wider use of the official standards wherever trading in American cotton is carried on. Applicants for licenses as classers under the United States warehouse act are required to submit to the same practical test as that for licenses under the cotton standards act.

PREPARATION AND DISTRIBUTION OF OFFICIAL COTTON STANDARDS

The grades for American cotton, 42 in number, remained unchanged. Tentative standards for the preparation of long-staple upland cotton of the grades Strict Middling, Middling, and Strict Low Middling have also been established. Standards for length of staple remained unchanged, except that on August 1, 1929, new original representations went into effect.

Practical forms or copies of the official cotton standards are prepared and sold to the public. During the year 4,667 boxes of the standards for grade and color (including 655 boxes of the tentative preparation types) were distributed, compared with 3,892 during the fiscal year 1929. The number of staple types distributed was 9,905 as against 17,195 during the preceding fiscal year. A sum of \$29,141.47 was collected from the sale of practical forms of the stand-

ards. Sales of loose and rejected cotton amounted to 495 bales, for which the sum of \$38,077.25 was received.

Various demonstrations of the standards at summer cotton schools were carried on in cooperation with southern agricultural colleges, but it was necessary to restrict these demonstrations in view of the extraordinary demands upon the boards of cotton examiners in connection with the certification of cotton under the United States cotton futures act.

Demonstrations of the standards in European markets continued. The technical representative of the United States, through contact with different European trade organizations and individuals, continued to give valuable assistance in encouraging the use of the standards for grade and color in accordance with the universal standards agreements as well as the use of the official staple types in foreign countries.

FUTURE AND SPOT MARKET INVESTIGATIONS AND COTTON PRICE QUOTATIONS

This project supervises the quotation of commercial differences by the designated spot markets in connection with the settlement for cotton other than Middling delivered on future contracts. It also publishes market information in order that producers, merchants, manufacturers, and others interested in spot cotton may be reliably informed as to the prices of cotton of various grades. Particular attention continued to be directed to quotations for the tenderable grades in the lengths of $\frac{1}{16}$ -inch and 1-inch staple, which lengths command a premium over $\frac{7}{8}$ -inch staple when delivered on future contracts. It is felt that through the cooperation of the spot exchanges with the representatives of the bureau, very satisfactory results were attained both as to the quotations for differentials between grades, and staple premiums for $\frac{1}{16}$ -inch and 1-inch cotton. As a result of the supervision maintained throughout the season almost no adverse comments from either buyers or sellers either with reference to differentials between grades or to the staple premiums were received.

A more general purpose of the project is to obtain accurate price data on cotton and to give them wide publicity in order to meet the urgent demand for market information. Telegraphic reports continued to be received from many domestic cotton centers, and weekly cable reports from large cotton centers abroad. These reports contained current information on the state of demand for various grades and staples of cotton, qualities sought and in supply, grade differences, basis prices, staple premiums, fixations, and other pertinent factors of cotton-marketing information. The data thus assembled were reviewed carefully and consolidated in a weekly report, which was telegraphed to the field offices, where it was distributed by mail and other means so as to reach every section of the Cotton Belt each Monday morning.

In addition to the cotton-market review issued weekly there was prepared at field offices a premium-staple report which covered the prevailing premiums for cotton above $\frac{7}{8}$ inch including the lengths from $\frac{1}{16}$ up to $1\frac{5}{16}$ inches.

Reports showing grade differences, and premium staple quotations for the lengths $\frac{1}{16}$ and 1 inch as furnished by the quoting markets, were prepared and distributed by the Atlanta office.

Newspapers and periodicals continued to be active in publishing the information assembled, and in this way the service was made available to a very large number of interested growers. The circulation of newspapers and periodicals that carried the various cotton-market news service reports is estimated at about 5,000,000.

PREPARATION AND DISTRIBUTION OF STANDARD GRADES FOR AMERICAN COTTON LINTERS

At the request of the industry, demonstrations of the use of the standard grades for linters were held in Washington, D. C., and at a number of points in the field. These demonstrations were attended by approximately 150 persons, many of whom subsequently took an examination to qualify as licensed classifiers. Sixty persons were licensed to classify cotton linters on the basis of the official standards, and their reports show that approximately 250,000 bales of linters, out of the total production of over 1,000,000 bales, were so classified. The demand for the classification of samples, submitted directly to the bureau's board of cotton linters examiners, increased nearly 100 per cent.

The consumers of linters have shown much interest in the tests of the felting qualities of the various grades of linters and in the arrays of the various lengths of fiber embraced in the standard grades that have been made. The studies of the felting properties of linters for mattress purposes have been made use of also by various branches of the Government in the purchase of mattresses.

GRADE AND STAPLE ESTIMATES (CROP AND CARRY-OVER)

The Secretary of Agriculture is directed by law to publish estimates of the grade, staple, and tenderability of cotton carried over on August 1 each year, and not less than three such estimates of the current crop.

In addition to the regular reports on the carry-over, and the crop for the United States as a whole, separate reports were prepared on the ginnings for each State, and cooperating gins were furnished with reports at the end of the season based on the samples furnished from their gins. These localized reports were especially valuable to the growers. Special charts showing staple length of cotton produced in definite areas were prepared at the request of agricultural workers in a number of States. Many reports and special articles were prepared on the basis of these estimates and a number of these were published by State and other agencies. Summaries and analyses have been made to show the trends of production of the various grades and staple lengths in different localities.

The last preliminary report of the number of bales ginned of the 1929 crop, based on the number of bales reported by the Bureau of Census March 20, showed 14,515,800 bales of American cotton and 28,800 bales of American-Egyptian cotton. According to this estimate, cotton ginned during the past season was lower in grade and slightly shorter in staple than the cotton ginned for the 1928 crop.

Of the 14,515,800 bales of American upland cotton, 9,179,000 bales, or 63.2 per cent, were white in color and Middling or better in grade. The proportions of other grades follow: Strict Low and Low Middling, 18.5 per cent; below Low Middling 366,600 bales were

reported; Spotted and Yellow Tinged, 11.8 per cent; Light Yellow Stained, Yellow Stained, Gray and Blue Stained, 49,100 bales.

An analysis of figures showed that 10,994,800 bales, or 75.7 per cent, were tenderable on future contracts. Of tenderable cotton, 9,437,100 bales, or 65 per cent of total upland ranged in staple from $\frac{7}{8}$ inch to $1\frac{1}{2}$ inches, inclusive, and 1,557,700 bales were over $1\frac{1}{2}$ inches in staple. Of the 3,521,000 bales which were untenderable, 600,800 bales were deficient in grade, 2,640,900 bales were deficient in staple, and 279,300 bales were untenderable in both grade and staple.

COTTON STANDARDS RESEARCH

The fiber and spinning studies include a series of studies having for their object the isolation of the various properties of cotton fibers and their evaluation in terms of spinning behavior and of yarn or fabric properties in the further development of actual standardization. The ginning studies are confined to surveys of ginning equipment and conditions and to fiber analyses.

FIBER STUDIES

Considerable progress has been made in the work with respect to the first grade factor; namely, color. Substantial contributions have been made in the development and improvement of both method and apparatus for determining this element of quality of cotton. These methods now find application in the checking of the universal grade standards prepared for distribution. In order to understand the importance of color in raw cotton, color facts are being traced through all the manufacturing processes. Effort is exerted to determine the stability of color in raw cotton and its manufactured products and the nature in which, and extent to which, it may change under given conditions.

Laboratory investigations of staple length and uniformity conducted throughout the year have added to previous knowledge of uniformity of dispersion of lengths of fibers normally occurring in cotton and to some extent the responses in terms of length to varying degrees of temperature and humidity. Apparatus has been developed which facilitates determinations of fiber length and uniformity and increases the accuracy of results.

One of the most important and least known phases of quality in raw cotton is that of so-called character. Microscopic, microchemical, and X-ray diffraction analyses of samples of known and unknown origin are being studied in an effort to obtain information fundamental to an understanding of the natural biological variations in fibers. Special consideration is being given to fiber development, structural components, and morphological features such as fiber width and thickness, cross-sectional area and shape, cell-wall development, and convolutions. Incidentally the results should indicate whether the fiber abnormalities or variations which are so vital to standardization problems represent retarded, arrested, or deteriorational phenomena. Detailed studies are being made on the composition and classification of neps and on the preparation of the ginned lint. Information of this type, supplemented by that from other phases of the program, is expected to serve as a basis of comparison of unknown commercial samples, to further the future es-

establishment of scientific specifications for fiber qualities, to give a physiological explanation of color, and to indicate the degree to which color may serve as an index to other associated fiber characteristics and properties. The information should contribute to knowledge of the changes that take place in the fibers as a result of environmental ginning and manufacturing conditions.

In connection with all of the fiber, spinning, and ginning studies, a careful analysis is being made of cotton-classing methods in an effort to learn the fiber properties considered, especially in appraising length and character; the relative importance attached to each; the nature and extent, if any, to which judgment of one factor may be influenced by sensations produced by another; the variations due to the personal equation; and the influence of the humidity, temperature, light, atmospheric pressure, density of sample, etc., on the judgment of length, color, leaf, preparation, and character. Information of this type is needed in order to facilitate the most accurate, uniform, and consistent cotton classing and application of the standards.

SPINNING STUDIES

Spinning, including all of its preliminary processes, constitutes one of the most important methods in cotton technological investigations because it is the sole medium of translation of data obtained from the fiber and ginning studies. Considerable spinning work has been completed, employing standard commercial manufacturing machines, organizations, and settings. A large body of information has been obtained for samples embracing many different qualities and a broad and general background with particular reference to the standards, ginning, harvesting, and breeding has been established.

Incidental results of the spinning work have been the derivation of methods for computing waste and deviation, which resulted in saving in time and effort in working up data; and determination of size of sample.

GINNING STUDIES

Cotton ginning, involving both the preliminary process of extracting and cleaning and the major operation of separating the fibers from the seed, constitutes one of the most important factors influencing the quality of American cotton and its standardization. Need for the improvement in cotton ginning has been urged by every branch of the cotton industry in this country and abroad, it being claimed that the preparation of American cotton is not as good as it formerly was. That is, the ginned lint appears on the whole to be rougher, more gin cut, and more neppy than formerly. Efforts to improve quality of ginning have been handicapped by lack of scientific information and by the large number and complexity of the factors in the seed cotton and in the ginning processes. Moreover, a scientific approach to the problems of ginning has been impeded both by lack of methods of measuring the effect upon the ginned fiber of variations in seed cotton and in the ginning processes and by a lack of facilities for varying sufficiently and controlling the conditions of ginning. Recent developments in fiber analyses have in large part removed the first of these obstacles.

Under an act of Congress approved April 19, 1930, plans have been made by the Bureau of Public Roads for the erection of an experimental cotton-ginning plant. The Bureau of Public Roads will have the engineering responsibilities, and this bureau will make analyses of the fibers in an attempt to develop some of the fundamental principles of cotton ginning, cleaning, and extracting and to promote a more exact understanding of the fundamental relationships which exist between the properties and conditions of the seed cotton, the mechanical conditions of ginning, and the resultant quality of the ginned lint.

The results obtained from preliminary ginning tests indicate that the information to be obtained from the laboratory analyses suggested by data pertaining to the more purely engineering and economic phases will furnish a scientific basis for records concerning (1) a more scientific technic of gin operation, (2) improvement in gin machinery and organization, and (3) educational work in the interest of improved gin operation generally.

SUMMARY OF STORAGE FACILITIES

A survey was made to determine the extent to which the storage facilities for cotton are adequate to handle the crop. These data will show the location, kind, capacity, compress facilities, storage cost, and concentration privileges for the storage facilities for cotton in the United States. This information is to be supplemented by data showing the extent to which storage facilities west of the Mississippi River have been used during the last two years.

SOUTHWESTERN IRRIGATED COTTON QUALITY PROBLEM

During the year 51 test lots of cotton were collected and arrangements made for tests. All data have been secured on each of these lots, such as the alkalinity of the soil on which the cotton was grown, the hardness or imperviousness of the land, whether it was good land, and whether there was sufficient irrigation. Each lot was grown under a different condition, and the date of harvesting was noted in each case.

Data on the movement of irrigated cotton for the season 1927-28 were obtained. In 1927-28 records of merchants showed that they handled 48,801 bales of cotton; 2,000 bales going into domestic consumption and 46,801 bales of cotton into foreign consumption. In 1928-29 these same merchants handled 108,610 bales of cotton; 1,148 bales for domestic, and 107,462 bales for foreign consumption and carry-over. Data on the movement of about one-fifth of the irrigated cotton grown in 1928-29 have been checked thus far. These results show that about 1 per cent of the irrigated cotton grown for the past two years went into domestic consumption, and that about 99 per cent was consumed abroad.

Data have been obtained on the organization which a mill has used in the successful manufacture of irrigated cotton during the last seven years. It was found, among a number of other things, that the roll settings used by this mill were different from those used by mills spinning rain-grown cotton of the same staple length. The commercial-mill tests which are being used to check the production factors are also being used to study the behavior of irrigated cotton as compared with rain-grown cotton under the same organization.

COTTON PRICE STUDIES—RELATION OF QUALITY TO PRICE

As a basis for determining to what extent the central market demands for cotton of different qualities are accurately reflected in the local markets in the form of price differences paid to individual growers for different grades and staple lengths of cotton, price data for approximately 170,000 individual bales of cotton in 157 local markets representing as near as possible a cross section of the local markets in the country were collected during the season 1928-29, and data for approximately 130,000 individual bales of cotton in 124 local markets were collected during the season of 1929-30.

An analysis of these data showed that the proportion of the premiums paid in the central markets for white grades above Middling which were reflected in the local markets in the form of price differences paid to growers, varied from less than 20 per cent for Strict Good Middling to less than 50 per cent for Strict Middling; and the proportion of the discounts in the central markets for white grades below Middling which were reflected in the local markets varied from about 40 per cent for Strict Low Middling to about 75 per cent for Good Ordinary. Only 12 per cent of the discounts made in the central markets for cotton with a staple length of thirteen-sixteenths of an inch and under were reflected in the local markets in the form of price differences paid to growers. The proportion of the staple premiums in the central markets which were paid to growers varied from less than 15 per cent for fifteen-sixteenths of an inch cotton to less than 40 per cent for cotton with a staple length of $1\frac{1}{8}$ inches.

Spot quotations in central markets are probably more nearly correct now than ever before, but there is need for the development of more systematic and uniform methods of determining spot quotations. To ascertain to what extent the methods used in arriving at these quotations at the present time can be improved, a qualified analyst has been stationed in New Orleans, La., to work with the chairman of the board of cotton examiners, who is responsible for quoting the New Orleans spot market. Results obtained from this work will be issued in the near future.

COTTON DEMAND, TRENDS, CHANGES, AND CAUSES

Work on this project was started a little over a year ago to meet the need for information relative to world demand for American cotton. The project as now outlined embraces a study of the factors affecting world consumption of American cotton.

Competition between American and foreign cotton has caused considerable concern in this country during the last few years. It is believed to be essential to the best interests of cotton farmers as well as others engaged in the cotton industry of the United States that facts regarding foreign competition be readily available. A complete and comprehensive analysis of this problem is one phase of the research work under this project. Such an analysis includes a study of the trends and changes in the world consumption of each growth of cotton and the various factors such as price, quality, range of substitution, preferences, costs, and other factors which affect the competition of American cotton with other growths.

A study of the world consumption of cotton by growths has been completed, and the results have been prepared for publication. This study reveals a marked expansion in the cotton-manufacturing industry during the 5-year period 1924-25 to 1928-29 when average annual world consumption of cotton reached the highest level on record. Annual consumption during this period was more than 3,500,000 bales greater than during the pre-war period. American cotton constituted 62.4 per cent of total world consumption during the five pre-war years, 60.2 per cent during the five war years, 59.2 per cent during the five years immediately following the war, and 59.7 per cent during the current 5-year period. The United States leads the world in the mill consumption of cotton, consuming on an average more than twice as much as Great Britain, the next largest consumer.

Annual consumption of American cotton during the last four years, 1925-26 to 1928-29, as compared with the pre-war years, 1909-10 to 1912-13 has increased approximately 1,800,000 bales. Annual consumption of American cotton in Great Britain has decreased about 1,400,000 bales, while Japan has increased her consumption of this growth by about 800,000 bales. The continent of Europe has regained its pre-war level of consumption of American cotton. The total net increase in annual world consumption of American cotton during this 20-year period has been about 1,800,000 bales.

Through the assistance of the foreign representatives of the division in Europe considerable progress has been made on the study dealing with the factors that affect the competition of American cotton with cotton of other growths. Apparently, price has been the greatest single factor causing increased foreign consumption of exotic growths as compared with American, during 1929-30. Depressed conditions in the spinning industry have caused spinners to be extremely cautious in buying, and this has been an important influence in turning them to these outside growths. A number of European spinners consider the deterioration in the quality of American cotton, together with the improvement in the quality of a number of the foreign growths, as having a great influence in the shift from American to other growths of cotton.

A knowledge of the staple of cotton grown in each of the foreign countries is considered basic to a study of the competition which each of these growths offer American cotton. To supply this information data relative to the staples of foreign cotton are being assembled.

ADAPTATION OF COTTON TO NEW AND EXTENDED USES

This work is helping to sustain the consumption of cotton and is laying a foundation for future increases in its use. Many requests and inquiries are received from cotton manufacturers, bag manufacturers, and others who stand ready to put into production new fabrics.

Cotton bags for consumer packages for potatoes and citrus fruit have been developed in cooperation with the North Carolina State College of Agriculture and Engineering. A unique feature of the potato bag is that it has an open-mesh side where the potatoes may be inspected and a close-mesh side suitable for carrying the brand. This feature gives to the seller valuable means of establishing his

brand in the minds of consumers. Bag manufacturers have announced that they expect to put this fabric into commercial production for handling the late summer and fall crop of potatoes.

A study of ways in which cotton may be used in power laundries has been completed, and a report entitled "Cotton Consumption in Power Laundries of the United States—1928," has been issued. This study showed that approximately 52,000 bales of cotton were consumed by power laundries during 1928 and that the greatest potential field for increasing the use of cotton in power laundries lies in the purchase of supplies such as soap chips and other detergents, in cotton bags, subsequently using these bags for collecting and returning laundry to customers.

The study of cotton-picking sacks, cotton-picking sheets, and tarpaulins in the Cotton Belt has been continued, and a report will soon be issued. Several tests on sheets made from both cotton and burlap are being carried on in cooperation with the experiment station of North Carolina and the Clemson Agricultural Experiment Station. Preliminary data seem to indicate that the cotton sheets, although lighter in weight and less expensive than the burlap sheets, will hold up better, but the data gathered so far are too fragmentary to warrant definite conclusions.

Studies designed to develop an economical and a suitable cotton-patching material for cotton bales is now under way in cooperation with the North Carolina State College of Agriculture and Engineering. Several patterns have been completed, and others are in various stages of development. These will be studied in the laboratory to determine the strength, stretch, etc., and tests will be made at compresses.

COTTONSEED STUDIES

A plan for grading cottonseed for crushing purposes has been perfected which makes it possible to base the price paid the grower on the oil and protein content of his product.

The free fatty acid content of the oil in the seed has been found to be so correlated with deterioration in all the products of cottonseed that it could be used as an accurate measure of the amount of deterioration that had taken place in cottonseed at the time of purchase and sale.

At the convention of the National Cottonseed Products Association held in New Orleans, La., May 12–14, 1930, both the method of grading cottonseed and the method of measuring deterioration in cottonseed developed in these investigations were adapted and incorporated in the trading rules of the association. These rules will be used in the purchase of cottonseed beginning with the 1930–31 season.

DIVISION OF FRUITS AND VEGETABLES

WELLS A. SHERMAN, *in Charge*

MARKET NEWS SERVICE ON FRUITS AND VEGETABLES

The market news service was expanded by opening new branch offices at Cleveland, Detroit, New Orleans, and Seattle. The former field station at Spokane was changed to a permanent market station. At the close of the year, 22 branch offices were in operation. All but one of these offices were connected with the bureau's leased-wire

telegraph system, which connects the various field offices with Washington and serves as a means of rapid dissemination of market news, including arrival and price information, shipment and movement reports, and other information covering both producing sections and terminal markets. In addition to the 22 branch offices, 39 temporary field stations were in operation for varying periods in important producing sections. The leased-wire telegraph service was extended also to four additional State offices, where State officials give the information gathered by the bureau wide publicity for the benefit of producers and others in their sections.

A total of 13,546,954 mimeographed market reports was issued from Washington and the field offices. Although the radio and other means of publicity have been made greater use of each year, the demand for the mimeographed reports continues to increase, and greater dependence is placed upon the bureau each year for market information.

CARLOAD-SHIPMENT INFORMATION

Daily shipments of 35 products were reported telegraphically by the carriers, and complete market reports in season were issued on 22 of these. In addition special reports were issued at Pacific coast stations on artichokes, broccoli, cherries, chicory, plums, and prunes and in Florida on citrus fruits.

Daily telegraphic reports on selected perishable products in season were received in Washington from several hundred transportation lines, these reports showing the number of cars originating in each division superintendent's territory. About 65 of these reports are known as "consolidated wires," each covering an important railroad system or major portion of such a system. Approximately 400 individual division superintendents or other reporting officials, chiefly of the smaller transportation lines, sent daily telegrams in season. About 15,000 local freight agents and express agents sent monthly reports by mail, covering a greater number of products than those in the daily telegrams. These reports amplify and also serve as a check upon the daily telegraphic reports. A net total of 1,073,707 carload shipments was reported by the carriers.

In addition to the reports forwarded to the Washington office, the carriers furnished special information daily to the field stations on the movements of certain products. Information with regard to numbers of carloads moving and destinations is very valuable to shippers and helps to guide them in consigning their produce to the market where the supply is lightest and the demand best.

UNLOAD REPORTS FROM PRINCIPAL MARKETS

Regular periodical reports of unloads of important fruits and vegetables were received from 66 cities. Representatives of the bureau in 29 markets and railroad agents in 37 other markets furnished the unload reports on 19 of the most important fruits and vegetables.

Much of the unload information has been prepared in condensed form and these tabulations have been mimeographed to supply the increasing demand for such data on the part of growers, shippers,

members of the trade, transportation officials, and schools and colleges. The figures also were used in summaries of shipping seasons in producing sections and in other reviews. The data are of great value because they show the monthly and annual receipts of various products in large consuming centers, as well as the sources of supply. The bureau's representatives in various markets frequently prepared press releases or mimeographed statements for public distribution on the basis of these figures.

REVIEWS, SUMMARIES, AND SPECIAL REPORTS

A corps of four or five employees maintained current tabulations of market prices and conditions for all the leading markets and shipping points, prepared special reviews and summaries based largely on these statistics, wrote articles for trade papers and farm journals, and handled a large correspondence on miscellaneous marketing problems.

Many weekly and monthly reviews and summaries have been prepared, as well as special reports upon particular phases of the work. Constant cooperation has been maintained with newspapers, periodicals, and radio stations, and information has been prepared in suitable form for various types of publicity. Short reviews adapted to different sections of the country were furnished weekly to about 20 farm journals and 35 newspapers and press associations.

A summary of the daily information published, together with a review of the marketing season, has been prepared at the closing of each temporary field station. This report is particularly valuable to the farmers in the vicinity of the field station, since it points out the important factors to be considered in planning the following year's planting, harvesting, and marketing operations. During the past year 50,000 copies of 65 different summaries of this type were issued.

INSPECTION SERVICE ON FRUITS AND VEGETABLES

The total number of inspections of fruits and vegetables again showed a substantial increase over the preceding years. Shipping-point inspections increased by 14,500 cars over last year and receiving-point inspections by 7,108 cars. The total number of inspections for both services was 288,439 as compared with 266,831 for last year.

RECEIVING-POINT INSPECTION

Offices were maintained at 42 of the most important central markets and inspections were made at these and adjacent points. A total of 44,740 carloads of fruits and vegetables was inspected as well as very substantial quantities of various products for the United States Navy and Marine Corps and other governmental agencies.

Agreements have been entered into in a number of cities with railroad companies and other agencies which handle large quantities of fruits and vegetables for the inspection of all of their receipts. In consideration of the large volume of work special rates have been made for the service.

EXPORT STANDARDS FOR APPLES

The use of the export standards for apples which were promulgated in October, 1928, has been continued in both shipping-point and receiving-point work. With the aid of these standards foreign buyers have been able to secure official information regarding the suitability of lots of apples for export. Certification of apples on the basis of these standards has eliminated much misunderstanding between buyer and seller and provided a basis of trading which established more cordial relations between them. The bulk of this work has been in New York City, but a great many cars were certified at shipping points on the basis of the export standards.

SHIPPING-POINT INSPECTION

In 25 States there was an increase in shipping-point inspection during the year, and 13 States showed a decline. The net increase over the previous year was 14,500 cars and the total number of cars inspected 243,699. Colorado showed the greatest increase of any State, the increase amounting to approximately 12,000 cars.

Full-time Federal supervising inspectors were maintained during the entire year in Idaho, Washington, Utah and Oregon, while those assigned to Texas, Florida, and Maine devoted most of their time to the shipping-point work in those States. In California and Colorado the supervisors are employed jointly by the State and the department for the entire year. With Louisiana, Indiana, Ohio, and South Carolina, agreements were made providing that the shipping-point supervisor, cooperatively employed, may devote such time as is not required for the supervision of inspection work to extension work in grading and standardization. These arrangements have proven highly satisfactory from the standpoint of service rendered to growers and to this bureau because of the advantage of having a supervisor on the ground through the entire year. This is not possible in most of the States where the supervisor is engaged only on inspection work.

INSPECTION OF CANNERY TOMATOES

Experimental work in connection with the inspection and grading of cannery tomatoes has been carried on for several years. During the last year this work was conducted as a regular activity of the shipping-point inspection service in Indiana, Colorado, and New York. During the fiscal year 22,738 tons of tomatoes were inspected in Indiana, 5,528 tons in Colorado, and approximately 5,000 tons in the State of New York. All of these tomatoes were graded by licensed inspectors when delivered at the factories. This phase of inspection and grading work is steadily growing and will be extended to additional States next season.

RESEARCH AND STANDARDIZATION

During the fiscal year standards for 4 additional fruits or vegetables have been issued, and 11 sets of grades have been revised.

United States standards for 46 commodities have now been issued by this division. As in some instances 2 or more standards are necessary for 1 commodity because of different types, or different

conditions in various producing areas, a total of 59 standards has been issued. Requests for standards for 15 additional products have been made by commercial interests, and some work has been done in connection with grades for them.

An outstanding development in the standardization work has been the increasing interest shown by canners and producers of products used for canning, in the establishing of standards for canning crops.

Grades for cannery tomatoes were issued in 1926. Approximately 57 canners located in Colorado, Indiana, New York, Pennsylvania, New Jersey, Virginia, Maryland, Delaware, Ohio, and Utah have expressed their intention of contracting with their growers on the basis of these grades for the 1930 crop. Under these contracts each load of tomatoes is inspected when delivered to the canning plant by the grower. To facilitate the uniform interpretation of certain of the United States grades by the inspection service, photographs have been prepared showing various degrees of injury permitted in different grades. Colored photographs and models for certain commodities have been prepared.

Economic study of various industries is a type of work which has continued in popularity during the year. Cooperative organizations and shippers have asked the assistance of this division in ascertaining market requirements and obtaining constructive criticisms of the trade with a view to widening the market outlet for their respective commodities.

The division of fruits and vegetables has cooperated with other divisions of the bureau and with State agencies in economic surveys of a number of important products, including northwestern fresh prunes, potatoes, apples, pecans, grapes, and olives. The results of these surveys have been published by the department and by State agencies, and have been carried to the producers through public addresses and by other means.

The increasing use of the motor truck in transporting fruits and vegetables is changing marketing conditions. Highly perishable fruits are frequently hauled 600 miles or farther to market. Within a radius of 100 miles of many cities a large part of the fruit and vegetable supply is now carried by truck. The redistribution of fruits and vegetables to the trade territory surrounding large cities as well as the incoming supplies from the adjacent areas are handled largely by truck. Statistics of rail shipments of fruits and vegetables have become inadequate for purposes of marketing studies or market-news reports. Studies have been undertaken in widely separated sections to determine the importance of the motor truck in fruit and vegetable marketing; its advantages and disadvantages; and other pertinent information.

Two reports on motor-truck marketing issued during the year related to conditions in southern Indiana and southern Illinois, and in western New York and the Cumberland-Shenandoah section. The reports indicate that exclusive of market-garden and canning supplies, in 1928, 38 per cent of the fruits and vegetables in southern Indiana were shipped by truck. For southern Illinois the corresponding figure was 23 per cent; for western New York, 20 per cent; and for the Cumberland-Shenandoah section, 11 per cent. A similar survey is now being made in southwestern Michigan.

This bureau has cooperated with the New Jersey State Agricultural College, the New Jersey Department of Agriculture, and the New York Food Marketing Research Council in making a study of the motor truck as a carrier of fruits and vegetables to greater New York.

STANDARD CONTAINER ACTS

Work under the standard container acts continued to increase. More than 6,000 containers were tested by the bureau, an increase of nearly 50 per cent over the preceding year. The standard container act of 1928 requires the manufacturers to submit container specifications to this bureau for approval. The manufacturers have shown a remarkable willingness to cooperate with the bureau in the work, and the chief problem of the bureau is to handle the large volume of work entailed and at the same time carry on educational work to bring about complete compliance with the law.

PRODUCE AGENCY ACT

The number of complaints under the produce agency act continued to increase. Nearly 400 cases were received during the year, 262 cases were personally investigated, and 34 were referred to the Department of Justice for prosecution. Settlement of 114 cases, involving more than \$17,000, was reported to the bureau.

PERISHABLE AGRICULTURAL COMMODITIES ACT

On June 10, the President approved the perishable agricultural commodities act, which is intended "to suppress unfair and fraudulent practices in the marketing of perishable agricultural commodities in interstate and foreign commerce." Work was begun on the rules and regulations immediately after the approval of the act. At the close of the year the regulations were still under consideration.

An organization plan for handling this work has been drawn up, and the force that is now administering the produce agency act will be merged with the new organization, and most of the cases under the produce agency act will be handled under the new act, which applies to dealers and brokers as well as commission merchants.

LIVESTOCK, MEATS, AND WOOL DIVISION

C. V. WHALIN, *in Charge*

DIRECT BUYING OF HOGS

Study of the direct buying of hogs was begun and will be materially expanded during the coming year. Available data relating to prices of hogs, corn, and pork products and hog production and hog marketings were analyzed. The results obtained thus far indicate that marked changes have taken place in the relationships between farm prices in certain States and between these prices and the prices at leading markets. Although the causes for these changes have not been fully determined, indications are that they are associated with shifts in hog production and the growth of direct buying and selling.

The variations in yields of hog products as reported by wholesale slaughterers using different buying methods are being analyzed to ascertain if they would show any advantages or disadvantages in the methods practiced.

Analysis was made of the hog purchases of slaughterers in different sections and using different buying methods to ascertain the monthly and yearly variations in the number and weights of hogs bought. Information of this character is helpful to producers' organizations that seek better market outlets for their hogs.

Existing material on freight rates and the freight-rate structure in Iowa was studied with a view to analyzing the transportation problems in hog marketing. The possible relationship of highway development and motor-truck transportation to changes in the methods of marketing hogs was given attention. The question of proper price differentials for hogs transported varying distances by motor truck in comparison with those transported by rail is one which needs to be given considerable study, since it is of much concern to both producers and slaughterers of hogs in establishing and maintaining satisfactory trade relationships and working out proper buying and selling policies.

A brief field survey of hog-marketing conditions in Iowa was made late in the year with a view to making plans for a comprehensive study of the developments taking place in hog-buying methods and of analyzing the entire direct-buying situation to determine the relative advantages and disadvantages to buyers and sellers of the different marketing methods in use.

PRICE AND SITUATION REPORTS

An analysis of the price and supply situation as it relates to hogs has been prepared each month as part of the monthly price report on agricultural products released by the bureau. This report has served to keep producers and distributors informed as to economic developments by indicating trends from month to month in the hog and pork situation.

Seventeen analytical statements on the economic situation as it related to cattle, hogs, and sheep were prepared during the year for radio broadcast over a national chain of stations. These and other statements carrying economic information were mimeographed and given wide distribution by mail and through the press.

The collection and publication of weekly and monthly price data on beef steers by grade and weight was continued. These data have served as a valuable index of the current beef-supply situation and have been very useful in the preparation of outlook and price reports.

The results of a comprehensive study of the beef-cattle industry in the southern Appalachian region were prepared for publication to help cattle producers in the States extending from Pennsylvania to North Carolina, inclusive, as well as to producers of grass cattle in other sections.

Considerable progress was made in a number of other economic-research projects, including a study of the monthly variation in prices of heavy hogs per 100 pounds at Chicago from 1890 to 1929 as compared with variation in receipts; daily percentage distribution of hogs shipped direct to packers, total shipments of hogs, hold-over

of hogs, and trucked-in hog receipts at the Chicago stockyards for 1928 and 1929, with the object of correlating changes in these factors with changes in daily top prices and daily average prices paid for hogs; and daily "drive-in receipts" of livestock at eight of the principal hog markets, with the object of determining the effect of radio market reports and other factors on the supply of hogs received at these markets.

GRADE STANDARDIZATION

HIDES AND SKINS

Approximately 700 tests were conducted at various tanneries in the Eastern States in an effort to correlate grades of hides and skins with grades of leather. Heavy unbranded cow hides from big packers, light cowhides and heavy unbranded bull hides from small packers, extremely light country hides, and New York City kips were graded before and after tanning. About 2,000 sole-leather backs, bends, and bellies were also graded for further correlation purposes. All of the hides and skins were graded in accordance with the tentative schedules of market classes and grades of hides and skins which were drafted in this division. The practicability of this method of classifying cattle hides according to quality has been demonstrated, but much research work remains to be done on calfskins, horse hides, and sheepskins.

LIVESTOCK AND MEATS

Further grading and slaughter tests of hogs and lambs were made to determine more definitely the number of grades and the limitations of each. The tentative standards were modified somewhat, and later they will be presented to the trade for suggestions. Plaster models of three types and six grades of slaughter hogs made in the bureau have been very helpful in illustrating the difference in grades and types of hogs. There has been considerable demand for these models from extension workers.

LAMB GRADE STANDARDIZATION SLAUGHTER TESTS

A lamb and mutton slaughter test was conducted in cooperation with the Bureaus of Animal Industry and Home Economics. It was found that grading results of the live lambs and ewes correlated closely with the grading of their carcasses. The live weights of the lambs varied from 77 pounds for the Choice grade to 40 pounds for the Culls. The average dressing yields of the lambs and ewes showed a gradual decrease from Choice to Cull, with a range of 11.1 per cent on lambs and 7 per cent on ewes. The percentage loss in chill room was slightly less for the lower than for the higher grades. The grading committee working on cooked meat found little difference in tenderness and flavor of lean meat of the several grades. This was contrary to expectations, and further studies will be made to verify the results. There was a high correlation between certain characteristics of the live animal and the carcass grades.

HOG GRADE STANDARDIZATION SLAUGHTER TESTS

A number of hog-slaughter tests were conducted. The live hogs were graded according to the tentative standards already set up by the bureau. Dressing yields, measurements of carcass, and cutting yields of wholesale cuts were obtained. The carcass measurements showed a direct correlation between the grades of live hogs and dressed carcasses. Much other valuable information was obtained.

QUALITY OF MEAT RESEARCH

The study of the factors that make quality and palatability in meat, conducted in cooperation with the Bureaus of Animal Husbandry and Home Economics and 25 State agricultural experiment stations, was continued with satisfactory results. In connection with this study 680 cattle, 500 lambs, and 764 hogs were graded and scored according to the division's grade standards.

More than 3,000 cattle and about the same number of lambs have been graded during the 5-year period 1925 to 1929. Statistical studies have been made of the various characteristics of the live cattle and their carcasses, and the data are now believed to be of sufficient volume and of such character that results of the work can be summarized for publication.

Results of cattle-grading work conducted in cooperation with the Bureau of Animal Industry and a large number of the State agricultural experiment stations, involving more than 2,000 cattle, showed that width and depth of body, shape of head, and refinement are reliable indices of the grade of the animal as a feeder. However, feeder-cattle grade has not shown a high correlation with rate of gain during the feeding period. In this grading of feeder cattle the factors that indicate the conformation, finish, and quality of the carcass at the end of the feeding period were the primary considerations.

MARKET NEWS

Branch offices were maintained in 24 cities, and market conditions and prices at 30 of the important markets of the country were reported. State agencies assisted the Federal department in financing the market-news service at a number of points.

Extension of the southern circuit of the bureau's leased wire telegraph system and the establishment of a circuit reaching the Pacific Northwest enabled the bureau to extend the service to Jacksonville, Fla.; Montgomery, Ala.; Jackson, Miss.; Nashville, Tenn.; Seattle and Spokane, Wash.; Corvallis, Oreg.; and Boise, Idaho. At most of these points dissemination was effected largely by means of the radio and press, although at Jacksonville, Nashville, and Spokane arrangements also were made for mail release of incoming market information. Extending the leased-wire facilities to North Portland made it possible to render a more complete, timely, and accurate service by the division's office at that market.

Through extensions of the bureau leased wire and the broadening of contacts with various cooperating agencies, such as State departments of agriculture, the press, radio stations, telegraph and cable

companies, boards of trade, chambers of commerce, ticker services, and organized trade interests, the division's news service was made promptly available in all sections of the United States. The service was improved by giving constant attention to the style, content, and timeliness of the reports released, and by unceasing effort toward obtaining greater uniformity and understanding in the use of standard class and grade terminology. Efforts expended, both in improving the service and in broadening its scope, usefulness, and avenues of dissemination were met by evidence of ever-increasing interest on the part of producers and the trade.

Appropriations for the fiscal year 1931 will permit the expansion of the news service to include price and supply information on hogs sold in Iowa and southern Minnesota direct to packers; and for establishing and conducting a livestock market-news service at Nashville in cooperation with the Tennessee State Department of Agriculture. Much attention has been given to working out plans for these proposed expansions, particularly the service to be conducted in Iowa and southern Minnesota, where current information will be obtained for the first time on hogs sold direct to slaughterers. The need for this additional service is indicated by the fact that Iowa markets between 10,000,000 and 13,000,000 hogs annually, about 64 per cent of which now move direct to packers, and there are seven large interior meat-packing plants in that State and in southern Minnesota which slaughter approximately 5,000,000 hogs annually, most of which are purchased direct.

The meat market reporting service on western dressed meats which has been carried on for several years at Boston, New York, Philadelphia, and Chicago was continued. The service was expanded through the inauguration of daily reports covering market conditions and prices at New York City on locally dressed meats and by the establishment of a semiweekly report covering the San Francisco wholesale meat market. The need for this additional service had long been recognized. Locally dressed meats in New York represent approximately one-half of the total meat supply of that city and vicinity. For this reason both buyers and sellers study the division's reports regularly in planning their operations. Some selling agencies base their quotations to customers on the prices quoted in the reports, and one of the largest slaughtering plants in New York advises that distant buyers purchase meats in large quantities on the basis of the reports. The reports are of interest also to livestock producers in the Middle West, where most of the livestock slaughtered in and near New York City originates.

The San Francisco market is the only wholesale meat market on the Pacific coast which is reported by the division, and local methods of trading in both livestock and meats have made the division's reports of particular importance in bringing about a better understanding of standard classes and grades of dressed meats.

To meet certain demands for market quotations on hogs on a finer segregation of weights and grades than had been previously released, the division arranged to furnish the commercial telegraph companies with quotations on weight ranges of 20 pounds for hogs weighing from 140 to 220 pounds, and ranges of 30 to 40 pounds for hogs weighing more than 220 pounds. This service has proven very use-

ful where there is a marked tendency to buy and sell hogs primarily on a weight basis.

Considerable improvement was made in the market-news service furnished the press associations by revising and amplifying several of the reports and adding several special reviews and summaries. The radio service was expanded and improved in various ways. Approximately 100 radio stations are now broadcasting the division's reports.

Until recently the Buffalo Stockyards Co. had been furnishing its representatives and certain other interests, including a number of radio stations, with reports of the Buffalo livestock market obtained from sources other than the news service of this division. It is now using the division's reports for this purpose and is thus aiding in bringing the bureau's livestock standards to the attention of patrons of the Buffalo market.

The inauguration of mimeographed releases at Cincinnati was an important addition to the market news disseminating facilities of that office, and was made possible through the cooperation of local commercial interests.

Assistance and suggestions on marketing problems, and information relative to various phases of the market situation were given during the year to many producers and members of the trade by all field offices as well as by the Washington office.

Long-distance telephone calls and requests for information by telegraph increased materially. For example, a cooperative wool-marketing organization in one of the Eastern States requested and received special telegraphic reports covering quotations on certain grades of wool on the days that it offered wools at public auction by sealed bids.

Many letters received from producers and others told of specific instances where market information supplied was of material financial benefit. Trade interests at South St. Paul adopted the official Federal grades on calves in their open-market transactions, thereby tending to develop greater uniformity to price quotations and giving the market more stability. The division's representatives at that market assisted materially in acquainting producers with the new arrangement through radio talks, press, and mimeographed releases, and posters illustrating the various grades of live vealers.

Temporarily demoralized market conditions and sharp price reductions for dressed lamb in August, 1929, prompted the transmission of telegrams to State marketing officials in southeastern lamb-producing districts. These messages called attention to the condition of the market and the probable results of continued heavy shipments of lambs. Those acting on this information were undoubtedly saved thousands of dollars by deferring shipments until a later date.

Efforts were made to keep lamb feeders in Colorado and western Nebraska in constant touch with the market during the winter and spring when the need for such information was extremely urgent because of the unusually large lamb supplies. Special reports on the market for fed lambs originating in these areas were prepared at several branch offices and transmitted daily by wire to the Denver office for prompt distribution to producers and feeders.

Arrangements were completed with a number of newspapers to feature complete daily livestock-market reports, including comment

and detailed quotations, and specially prepared reports were written and transmitted regularly to the metropolitan and country press for publication in several hundred newspapers that had not previously utilized the service.

Despite the greater distribution of reports by the press, radio, telegraph, and telephone, the demand for mail reports continues to increase. This is particularly true in the case of special reports and those of a statistical character.

MEAT-GRADING PROJECT

The meat-grading service has proven to be very satisfactory in the 15 cities where it is available. Demand from commercial interests has increased as the service has become better known. More than 22,500,000 pounds of meats were graded during the year, approximately one-third of this being for the Veterans' Bureau, the Shipping Board, and other Government buyers. The service has been used extensively by the dining-car departments of several well known railroads that purchase graded and stamped beef for their dining cars regularly.

One other feature of the meat-grading service, which has brought its value prominently to the front, is its use in connection with the sale of pre-cut and ready-packaged, fresh (unfrozen) meats of all classes. This service was inaugurated in April, 1930, by a large food-products corporation with headquarters in New York, which operates eight packing plants in various parts of the country. Developments so far indicate that this method of retailing meats, involving the use of Government grade labels, may become an important factor in the meat trade.

BEEF GRADING AND STAMPING

Material increases in the quantities of beef graded and stamped are shown at practically all markets. A total of 48,548,579 pounds of beef was graded and stamped, this being an increase of 16,828,888 pounds over the amount for the previous year. Demand for this service from retailers continues to increase. Many large chain-store organizations operating markets in the eastern half of the country are now selling United States graded and stamped beef in their markets. In some instances full-page advertisements featuring Government graded and stamped beef have been used to bring this beef to the attention of consumers. Various hotel and restaurant supply houses are now handling Government-graded beef regularly. One of them, upon its own initiative, is arranging for an exhibit of Government graded and stamped beef at the annual convention of the association of hotel and restaurant men to be held at Cleveland, Ohio, this fall. The beef grading and stamping service is conducted under a cooperative arrangement involving receipts and disbursement of funds with the National Live Stock and Meat Board.

PUREBRED LIVESTOCK PRICE SURVEY

The eighth price survey on purebred livestock, covering sales in 1929, was made and the results summarized in 21 separate reports issued in March and April, 1930. This survey indicated that purebred-livestock prices during 1929 were slightly higher for beef and dairy cattle and slightly lower for hogs and sheep than those in

1928. This information tends to stabilize prices by keeping buyers and sellers informed as to prices and price trends throughout the country. The survey indicates that nearly 90 per cent of all pure-breds sell within a narrow range at prices not excessively higher than those paid for market animals.

THE STATISTICAL SECTION

Much of the basic statistical material used in the research work is obtained in connection with the operation of the market-news service. These statistics cover daily livestock prices of 60 classes and grades at 23 markets; daily fresh-meat prices of 43 classes and grades at 4 markets; daily cured-meat prices of 20 classes and grades at 4 markets; weekly wool prices at Boston; weekly, monthly, and yearly averages of prices; actual daily receipts of cattle, calves, hogs, sheep, and horses and mules at 18 markets; monthly gradings of meat by class; grading of Good, Choice, and Prime beef handled in the beef grading and stamping experiment, and many computations and summaries.

EDUCATION AND DEMONSTRATION

In keeping with the constantly increasing demand for information on grade standards, consumer preferences, marketing methods, and factors affecting market prices, educational work in these lines was continued. This work is conducted largely by means of demonstrations, exhibits, posters, charts, models, moving pictures, addresses, radio talks, correspondence, and press releases. Special reports dealing with meat grading and beef stamping, standardization, and the supply, demand, and price situation, were prepared for dissemination through the press and over the radio.

One representative, in cooperation with the United States Office of Extension, State extension services, and the Federal Board of Vocational Training, devoted the major part of his time to attending meetings of livestock producers, vocational agricultural teachers, and others interested in livestock marketing, where he gave demonstrations in livestock grading and delivered addresses on consumer preferences, market requirements, and methods of adjusting production to demands so as to bring increased returns to producers. In this work he carried out 29 assignments in 14 States, attended 9 State or district livestock association meetings, and held 84 demonstrations or livestock-improvement meetings which were attended by approximately 124,000 stockmen, bankers, and livestock specialists.

WOOL STANDARDIZATION

The use of the Federal wool grades has increased rapidly. Many new sets were issued, and large numbers of old sets were reconditioned and reissued. Sets were issued to producers, dealers, and manufacturers, educational institutions, and to the United States customhouses for use in the administration of the new tariff act.

At the request of the Wool Institute a classification was made of the wool-top production of the United States. More than 300 samples were analyzed and classified in accordance with the official standards. These samples were mounted and are being used as an exhibit by the Wool Institute for the guidance of its membership.

ROMNEY WOOL STUDIES

At the request of the American Romney Breeders Association, the bureau has undertaken the study of the wool of the Romney sheep. Romney breeders hope, through a careful study of the wool produced by the Romney sheep in this country and possibly in foreign countries, to develop definite standards for their breed. The Romney breeders were given instructions for drawing samples of wool from the fleece and forwarding them to the bureau for study. More than 500 samples have been received, and at the end of the fiscal year these were in the process of classification. When the classification is completed, the individual breeder will be notified of the grades produced by his flock, and a summary will be made of the gradings of all of the samples.

Much educational work has been done among wool growers in order to bring about a better understanding of the wool standards, and to demonstrate the best methods and practices in the handling of wool.

WOOL SCOURING AND SHRINKAGE INVESTIGATIONS

The wool scouring and wool shrinkage investigations were continued. Large numbers of samples of wool, submitted by agricultural colleges, county agricultural agents, and other extension workers, and by individual wool producers, were tested for shrinkage and yield. The tests in each instance embrace the operations of grading, weighing, conditioning, scouring, drying, reconditioning, reweighing, and calculation of yield and loss. The results of the tests are reported to the senders of the samples. The data collected are being compiled for use in the wool-standardization program and for dissemination to the public.

WOOL-UTILIZATION STUDY

The division has recently begun investigations relating to wool utilization. In this will be embraced studies of the various uses of wool including those for personal, household, commercial, industrial, scientific, and military purposes; the economic factors affecting the use of wool; the possibilities of expanding the present uses for wool; the effect of substitutes of natural and synthetic origin on the use and consumption of wool; the creation and development of new uses for wool. These studies are correlated with the wool-standardization work.

WOOL-STOCK REPORT

The quarterly wool-stock report was continued, periodical surveys being made of the stocks of wool, wool tops, and noils held by dealers and warehouses in the United States. The cooperative relations with the Bureau of the Census were maintained, whereby the stocks of wool held by manufacturers as reported by that bureau were combined with dealers stocks, and a joint report in mimeographed form was periodically released.

A service has been inaugurated whereby current economic information on wool and mohair is being released. These releases are issued approximately three times a week and make available pertinent and valuable information to those interested in these commodities.

MOHAIR STANDARDIZATION

With the completion of certain phases of the investigational work pertaining to mohair standardization, tentative grades for mohair were formulated, and distribution of practical forms of the grades was begun. More than 100 sets have been issued to dealers, manufacturers, producers and other interested in the work, for the purpose of obtaining comments and criticisms on the grades that can be used in the further development of the standards.

GRAIN DIVISION

H. J. BESLEY, *in Charge*

ENFORCEMENT OF THE UNITED STATES GRAIN STANDARDS ACT

The work was administered from the Washington office and from general field headquarters at Chicago. The central board of review and the force in charge of inspection efficiency were also located at Chicago. Under the direction of general field headquarters the divisional organization was operated as follows: Pacific coast headquarters, Portland, Oreg.; export division headquarters, New York; southeast division, headquarters, Indianapolis; Great Lakes division, headquarters, Chicago; and southwest division headquarters, Kansas City.

At the close of the year there were 37 district offices, 136 regular inspection points and 20 additional designated points, and 458 licensed inspectors.

CONFERENCE WITH CANADIAN OFFICIALS

Pursuant to Senate Resolution 220, which authorized the State Department, the Interstate Commerce Commission, the United States Shipping Board, and the Department of Agriculture to investigate and report on the alleged diversion of traffic in grain and other commodities from United States Atlantic ports through Canadian North Atlantic ports, arrangements were negotiated by the State Department with the Government of Canada for a conference between members of the State Department, the Department of Agriculture, and officials of the Canadian Government at Ottawa, Canada, on February 3, 1930. At this conference Canadian Government officials were requested to permit this department to establish and maintain United States inspectors at Montreal for the purpose of inspecting, grading, and certificating as to grade grain of United States production passing through the port of Montreal in foreign commerce.

CERTIFICATION OF PRODUCTS FOR EXPORT

During the year the Dominion of Canada Department of Agriculture issued an order requiring that importations from the United States into Canada of bran, middlings, mill feeds, corn, oats, wheat, rye, buckwheat, and other grains, for use in feeding livestock or susceptible of conversion into feed for livestock be accompanied by a certificate signed by an official of this department reciting the fact that such product had been grown in the United States. This division was charged with the task of making these certifications in order to facilitate the movement of commerce to Canada and to avoid costly delays and demurrage charges. The field offices not

only at border points but also at inland points of origin were called upon to certificate a large number of shipments of this character, with entire satisfaction to the Canadian Government as well as to producers and shippers in the United States.

The Mexican Government placed a quarantine against the importation of wheat from States in which flag smut was present, excluding specifically wheat from Illinois, Missouri, and Kansas. Certificates reciting the fact that wheat intended for shipment to Mexico did not originate in any of the three States mentioned were issued by the Plant Quarantine and Control Administration. That administration, however, was not organized to care for shipments which were loaded into cars in the interior and shipped to the border, and requested this bureau to employ the organization of the Grain Division to furnish information to plant-quarantine inspectors as to the origin of shipments.

REGULATORY ACTIVITIES

Administration of service and regulatory work is normally attended with more or less criticism but during the past year criticism has been negligible. This is due, in some measure, to increased inspection efficiency, to the better average quality of the crops, and the consequent small percentage of grain falling into the lower grades; but in larger measure to the better understanding on the part of farmers, country elevator operators, and others in the trade of the standards and the methods by which they are administered. This better understanding is mainly the result of the work of an educational committee in the division, with the assistance of district supervisors and the collaboration of the Extension Service, agricultural colleges, crop-improvement associations, and others.

The enforcement activities of the division fall into two classes: (1) Cases where, as agents of the Food and Drugs Administration, Federal grain supervision offices have undertaken to obtain compliance with provisions of the United States food and drugs act as that law applies to whole grain; and (2) cases under the provisions of the United States grain standards act designed to prevent fraud in grain transactions.

The ordinary practice of many terminal and export grain elevators is to mix and blend like grains of different grades and qualities so that the resultant mixtures will come within the minimum limit of the official standards for the grade No. 2 wheat, or No. 3 corn. According to contracts customary in the grain trade, the grade No. 2 wheat is the usual grade contracted for both in domestic and export transactions. Practically all of the mixing that is done in export elevators is of stocks of grain accumulated by and belonging to patron dealers of the elevator, and is performed at the order of such dealers. The amount of profit in the mixing operation depends on the quantity of low-grade cheap grains that can be added. In general, such mixing is not unlawful, but some dealers add foreign grain, screenings, and musty and distinctly low-quality grain, which practice is deemed unreasonable.

A spirit of cooperation has been noted among the dealers in working with the department to prevent the mixing of material which this office has considered unfit. Supervisors have made arrange-

ments whereby they secure samples of practically every car or larger lot of objectionable substances that arrive in their market. All of the samples are sent to general field headquarters for a decision. When the material is considered unfit for mixing, the fact is telegraphed to the field supervisor, who communicates it immediately to the interested parties and asks the possessor of the material for information as to its intended disposition. Experience has shown that ordinarily trade members who receive such notices willingly comply with them and keep the objectionable material out of human food channels. It was necessary, however, to carry one case to the Federal courts, where decision is now pending.

Each year several hundred carloads have been tagged as "unfit for mixing with sound graded wheat intended for human consumption."

Findings were published by the Secretary of Agriculture on the basis of hearings conducted during the previous year in three cases of violation of the United States grain standards act. Hearings were held in a number of other cases, and as a result penalties were imposed in several cases by grain exchanges of which the offending firms were members. Corrective action was brought about through correspondence or personal contacts in a large number of cases.

The year's records showed continued improvement in inspection efficiency and in intermarket uniformity in grading. This was due to improved supervision coverage of all inspection points and better supervision of intermarket movements. There was a general absence of trade complaints involving important intermarket grain movements. The general conformity to the official interpretations of the standards was greater than during the previous two years.

Intermarket supervision reports covered 154,496 cars of grain which were graded at different markets. This is approximately 9,000 cars more than were reported last year, and 30,000 more than were recorded during any previous fiscal year. Supervision information covering nearly 309,000 inspections is available from these reports and, with water-borne grain coverage, constitutes an effective uniformity and accuracy check on inspections of over 385,000 carloads of grain.

EDUCATIONAL ACTIVITIES

The education of country grain dealers, producers, and agricultural students in grain grading has been carried on through grading schools conducted throughout the grain-producing territory. Printed bulletins have been prepared and distributed, and a 2-reel motion picture illustrating grain-grading procedure was produced and used. These bulletins have met with a general demand and have been distributed to all agricultural colleges concerned with grain standardization, to secretaries of grain dealers' and producers' associations, and to other interested persons engaged in crop-improvement work who have requested copies.

Federal grain supervisors gave grain-grading instructions and demonstrations at 197 meetings widely distributed throughout the grain-producing territory, not including the west coast division. Six circular letters to grain inspectors giving general information for the improvement of inspection efficiency have been prepared.

The grain, milling, and agricultural publications have given wide distribution to material furnished them by this bureau.

During the year the board received and reviewed 24,891 official supervision and appeal samples from field offices, and 1,219 board appeals were handled. In 71 per cent of these appeals the supervisor's grade was sustained.

The field offices handled 80,087 appeals from decisions of licensed inspectors. In 56,262 of these cases, or 70.3 per cent, the grade assigned by the inspector was sustained. Approximately \$100,000 was returned to the Federal Treasury from fees collected for this service.

GRAIN INVESTIGATIONS

For several years workers in the United States Department of Agriculture have been searching for a fumigant suitable for use in the treatment of stored grain. During the last year a method of using ethylene oxide in combination with carbon dioxide has been developed that appears to be well adapted for the fumigation of grain in elevator bins. There is no fire hazard when the fumigant is properly applied, and the method of application is simple. The fumigant has no harmful effects upon the milling and baking qualities of the grain, leaves no odor, is not expensive, can be handled without danger to the operator, and when properly applied is 100 per cent effective against the grain weevil even at winter temperatures.

The insecticidal value of ethylene oxide-carbon dioxide mixture was developed in the Bureau of Entomology and the Bureau of Chemistry and Soils. This bureau participated in developing satisfactory commercial application of the insecticide to grain in storage in large terminal elevators.

MILLING, BAKING, AND CHEMICAL LABORATORY

Concentrated attention was given to the performance of a number of devices recommended as suitable to determine the moisture content of grain in an almost instantaneous manner. One device, the Tag-Heppenstall moisture meter, gave considerable promise under controlled laboratory conditions. By this device a moisture test can be completed in approximately one-half minute. This is to be compared with the time interval of 45 minutes now necessary to make a moisture test by the Brown-Duvel method (recognized as official under the grain standards act). The device is now being tried out on the new crop under various conditions. If it proves satisfactory, it will revolutionize the practice of moisture testing, as it will make possible the moisture testing of all samples of wheat, make possible the reporting of protein on a moisture basis, and be of use in making protein surveys and in combine-harvester studies.

A research project was carried on to determine the milling and baking properties of the five commercial classes of wheat of the 1929-30 crop. This study will make available data which will be useful to the Federal Farm Board. A study was made to determine how well the various numerical grades and standards for hard red winter wheat reflect milling and baking quality. A comparison was made of the relative milling and baking qualities of the spring

wheat grown in the United States and Canada. Over 900 milling and baking tests were made in covering these three lines of investigations.

The facilities of the milling, baking, and chemical laboratory were extended to other bureaus, and hundreds of tests were made of samples of grain for various purposes. Technical Bulletin 197, Milling and Baking Qualities of World Wheats, was prepared for publication.

RICE-GRADING SERVICE

The Federal-State rice-grading services conducted in Texas, Louisiana, and California were continued. The grading service in Texas was expanded to include milled and brown rice involved in foreign and domestic shipments and a considerable quantity of such rice was graded under Federal supervision and sold on the basis of Federal-State grade certificates. The standards covering rough rice produced in California were amended to make them more applicable to such rice. Nearly all rough rice produced in California is now being graded under Federal supervision. A number of lots of rough and milled rice were graded for the benefit of other branches of the Government, and lots of milled rice were graded for the War, Navy, and Interior Departments, and other branches of the Government that purchase rice on the basis of the Federal rice standards. One of the principal advantages accruing to rice farmers and other members of the rice industry from an official rice grading service based on Federal standards uniformly applied is that the sales price for rice so graded makes possible a reliable market-news service. Such a market-news service is now in operation in the bureau.

ARTIFICIAL DRYING OF GRAIN AT COUNTRY ELEVATOR

Investigations were conducted to determine the practicability of drying damp grain in a commercial grain drier by means of heated air. The tests showed that grain driers are practicable at country elevators located in humid areas where a considerable quantity of damp grain is ordinarily delivered from farms. Drying the grain artificially eliminates labor and permits combining earlier in the season, and after rains and dews. This in turn reduces the time required for harvesting, and prevents losses in standing grain due to hail, high winds, and heavy rains.

These investigations were conducted in cooperation with the Division of Agricultural Engineering, Bureau of Public Roads. The data secured in the investigations were compiled for publication.

FARM GRAIN STORAGE

Further studies were made of farm grain storage in cooperation with the Bureau of Public Roads. A report of these studies which discusses the economic advantages of storing grain on the farm and the general types and construction of farm storage plants under various conditions, together with the grain-handling equipment that is essential for the proper handling of bulk grain at a farm storage plant has been prepared for publication.

RICE-TESTING EQUIPMENT DEVELOPED

Two new rice-testing devices for determining the quality and condition of rice for grading, storing, and milling purposes were developed. A rice-scouring device for removing the bran from rough rice from which the hulls have been removed by means of the Smith shelling device was perfected and adopted for grading purposes. By means of this device it is now possible to determine definitely the amount and extent of any defect, such as heat damage, chalky kernels, etc., that may be present in the rough rice.

A mechanical sieving device for determining the quantity of foreign seeds and of broken kernels in any lot of rough, brown, or milled rice in a definite and uniform manner was designed and perfected, and was adopted for rice testing and grading purposes.

SEED-RICE SURVEY

Surveys were made in the southern rice-producing States and in California of the seed rice that was being planted and of the seed rice that farmers had intended to plant. Full analyses of the seed samples were made to determine the germination qualities of the rice and the admixtures of weed seeds and red rice in the seed rice. A high percentage of weed seeds and red rice and low percentages of germination were found in a high proportion of the seed lots. This information in detail was submitted to growers and to the banks and agricultural-credit corporations that loan money on seed rice and to the officials of the various rice growers associations, with the result that many lots of the seed rice that were being planted or which the growers had intended to plant were discarded and new lots of high-germination seed free of weed seeds and red rice were secured and planted.

BULK HANDLING OF GRAIN AND RICE

Investigations concerning the economic advantages of handling grain in bulk were continued on the Pacific coast. Similar investigations were begun in that area with reference to rice. Detailed comparative-cost data for each step or operation of handling grain in bulk and in sacks were secured by the Division of Farm Management. These data show that a material saving is made by harvesting and handling grain and rice in bulk. Assistance was rendered grain and rice farmers and managers of grain and rice storage plants in planning new bulk storages and bulk-handling equipment suitable for the conditions under which each was intended to operate.

SURVEY OF DOCKAGE IN WHEAT AND FLAX PRODUCED IN THE SPRING-WHEAT AREA

A survey was made of the dockage (separable foreign weed seeds) contained in the wheat and flax as threshed and marketed in the spring-wheat States. The survey showed that the threshed wheat and flax produced in that area contained a large quantity of weed seeds and other foreign materials.

Publicity was given to the data obtained in the survey through the press, radio talks, pamphlets, and posters. It is noticeable that considerable effort is now being made in that area to do more seed cleaning and to remove more of the weed seeds from the threshed grain before it leaves the farm.

DIVISION OF DAIRY AND POULTRY PRODUCTS

ROY C. POTTS, *in Charge*

RESEARCH PROJECTS

A study of consumers' habits, preferences, and demands for quality in eggs was undertaken at Boston, New York, Newark, N. J., and Washington, D. C., and in cooperation with the University of Illinois, at Chicago. More than 50 retail stores in these cities sold eggs of the four United States retail grades viz, United States Specials, United States Extras, United States Standards, and United States Trades, in cartons specially labeled to indicate their quality or grade. The volume of eggs of each grade and of private brands sold in these stores was ascertained weekly and compared with the volume of sales of eggs of private brand sold in an equal number of check stores. Personal contact was made with more than 2,000 housewives who bought their eggs in the first group of stores with a view to ascertaining the factors or conditions which influenced their actions in purchasing a particular United States grade or private brand of eggs.

Preliminary indications are that housewives either seek to purchase eggs of the freshest or best quality, or eggs that are low in price. It was apparent that consumers generally do not have definite information on the various qualities of eggs.

The general results indicate that eggs are not well graded for quality in retail channels and that there is much to be done in teaching both the trade and housewives the qualities of eggs of the various United States grades and the use of each grade of eggs for the purpose it is best fitted to serve.

Another egg-marketing study covered an analysis of the price-making forces in the New York egg market. An attempt was made to describe the forces that influence the price of eggs in the New York market, and to analyze the factors that influence egg prices in the spring, in the fall, and from month to month. The preliminary results of this study indicate that general price levels and trends can be forecasted with reasonable accuracy when conditions near normal prevail through the different seasons.

MARKET-NEWS WORK

The market-news work was expanded on the Pacific coast by the opening of new offices at Portland, Oreg., and Seattle, Wash., in August, 1929. Previously in those cities the local markets for dairy and poultry products were not included in the Government reports, and such information as was available was mailed from the San Francisco office. A distribution office was established at Spokane which, with the offices at Seattle and Portland, now makes it possible to give prompt market-news reports on dairy and poultry products to all the Pacific Northwest States.

Two new weekly reports were instituted at the Pacific coast offices—a weekly report of receipts of eggs at commercial egg-packing plants and a weekly report of butter production on the Pacific coast. These reports furnish information regarding commercial supply close to or at point of production, which is exceedingly valuable.

At the Boston office a weekly report of milk and cream receipts was instituted. This report is similar to the reports issued weekly

at the New York and Philadelphia offices for those markets and shows the State of origin. A weekly report of cream receipts at Chicago by States of origin was instituted by the Chicago office.

The monthly hatchery report was issued again this year beginning in February, with the cooperation of nearly 1,500 commercial hatcheries. This report provides an index of conditions in the baby-chick hatching industry and is one of the most valuable reports issued by the bureau for the poultry industry.

A monthly report of poultry canned by poultry-canning plants was instituted during the year.

STANDARDIZATION AND INSPECTION

With the opening of new offices in Portland and Seattle, the grading service on butter, cheese, and eggs was extended to those markets, where it was received with much favor by the trade. The United States grades were accepted by the trade as official for those markets. At Los Angeles a large butter-marketing organization made application for the grading of all the butter received from its member creameries. This is the second Pacific-coast organization to apply for the service on all of its butter supply and to use it as a basis for making payment to its creameries for their butter. In California and Washington this service is rendered in cooperation with the State departments of agriculture of those States.

At practically every market where the butter and egg grading service is rendered there was an increased demand for the service, especially where the privilege of issuing certificates of quality is used. During the year 12 firms applied for and were granted the privilege of issuing certificates of quality on eggs, and 9 firms applied for the privilege on butter. More than 30,000,000 pounds of butter and 50,000 cases of eggs a year are marketed with certificates of quality.

More than 155,000,000 pounds of butter and 382,000 cases of eggs were graded during the year.

In attempting to grade and label or brand American type Cheddar cheese, which is manufactured in various styles or shapes and is coated with paraffin to protect the surface, one of the problems has been to affix to the cheese itself a label or mark of the grade of the cheese. A special machine was developed in the bureau which successfully brands cheese through the use of an electrically heated stamp. The primary purpose of branding cheese with its grade and of approving the use of certificates of quality on or in packages of butter and eggs is to carry through to the consumer the grade of the product. A total of 561,000 pounds of cheese was graded during the year.

During the fall of 1929, the turkey-grading service was extended to shipping points in the Pacific Northwest and in Minnesota and to a larger number of eastern terminal markets, including Pittsburgh, Detroit, and Chicago. A total of more than 8,000,000 pounds of dressed turkeys were graded at both shipping points and terminal markets.

The inspection of poultry at canning plants for condition and wholesomeness was extended during the year to 8 plants in the New York district, 19 plants in the Chicago district, and 2 plants in

California. During the year a total of 25,260,000 pounds of poultry was inspected for condition and wholesomeness. Of this quantity approximately 4.3 per cent was rejected as diseased or otherwise unfit for food. Application was received from a group of 9 poultry-packing plants in Kansas, Nebraska, and Missouri for the grading of their dressed poultry and the labeling of each bird with a private brand and Government grade mark. This service has been established and is the first of its kind in the United States.

DIVISION OF HAY, FEED, AND SEED

W. A. WHEELER, in Charge

Satisfactory progress was made by the seed-verification service. More and more farmers are becoming acquainted with the merits of verified-origin seed, largely because of the attractive tag certificates adopted during the year. The service has passed the experimental stage and is now regarded by many seedsmen as a fixture in the seed trade.

More than 1,700 inspection certificates, covering approximately 36,600,000 pounds of alfalfa and 22,000,000 pounds of red-clover seed, were issued. Clover seed was included in the service, after having been dropped the preceding year. In certain sections there apparently is a greater demand for verification of red clover than of alfalfa; therefore this seed will continue to be verified as to origin during the next fiscal year.

To avoid confusion, all verified-origin dealers were required to use the same kinds of tag certificates, and a second (new) form of tag giving the address of the branch office which issues inspection certificates to the verified-origin seed dealer using this form was adopted so as to afford greater protection to the buyer.

SEED-REPORTING SERVICE

Reports covering prices, supplies, movement, and other data on 42 different kinds of field seeds were issued, and about 190,000 copies were distributed to growers, country shippers, seedsmen, retailers, banks, associations, newspapers in seed-producing districts, agricultural periodicals, and others.

Seed surveys were made and situation reports issued covering 25 different seed crops. They were based on information obtained from nearly 8,500 country shippers and more than 30,000 growers, supplemented by other facts and data obtained from State agricultural statisticians and by personal observations in the seed producing districts. Foreign information was obtained through contact with foreign correspondents. Reports regarding prospective demand, retail sales, and prices were issued after the data from more than 11,000 retail dealers had been assembled. Information regarding certified seed-potato production was obtained from State agencies. Special reports were issued on vetch, ryegrass, and sunflower seed.

GRAIN, HAY, AND FEED MARKET NEWS SERVICE

The outstanding development of the year was the extension of the grain and hay market-news service to the Pacific coast and the rounding out of the service into a national organization. Three new

offices were established—one each at Los Angeles, San Francisco, and Portland. These offices are now furnishing more comprehensive reports of the market situation in those areas and have made it possible to effect a much better distribution of the various market reviews to the agricultural interests on the Pacific coast. The work has been favorably received not only by the grain and hay growers but also by trade agencies. Requests for special information have been numerous, but reports indicate that the information being furnished is meeting the needs of the agricultural interests in that area.

The rice market-news service established during the previous year was materially broadened and improved. The cooperation of southern rice mills was obtained in the collection and compilation of more authentic and complete reports on the stocks and movement of rough and cleaned rice. The rice growers' associations and others in Texas, Louisiana, and Arkansas are obtaining regular market reports.

The hay market-news service was reorganized and extended. A special service on alfalfa hay was begun and a market review on alfalfa hay covering the principal alfalfa markets in the central West and on the Pacific coast is being issued weekly. More comprehensive information is being furnished on broomcorn than heretofore, covering the market situation in all of the principal producing areas.

REVISION OF UNITED STATES HAY STANDARDS

Extensive studies of the application of the Federal standards to the hay crops of the United States were carried on, and suggestions for changes from the hay trade were considered. Effective November 1, 1929, certain changes were made in the standards for all the principal kinds of hay. The color specification of the No. 1 grade and the special grade of Extra Green was reduced 5 per cent for Timothy and Clover hay and Johnson and Johnson Mixed hay, and 10 per cent for Prairie hay and Grass hay, in order to increase the quantity of hay that would fall into these two grades. The definitions of "hay" and "Sample grade" were changed so as to allow undercured hay to be graded as Sample grade instead of excluding such material from the definition for hay. Changes were made in the special grades for the principal kinds of hay in order to make the grade designations more descriptive of the type of hay to which they apply.

STRAW STANDARDIZATION

At the request of the United States Army, work was begun on the preparation of specifications for straw to be used by the Federal Specifications Board in purchasing straw for use in Government departments. It is planned to issue United States grades for straw which can be used not only by the Federal Specifications Board but also at central markets.

ALFALFA-MEAL STANDARDIZATION

The field and market surveys on alfalfa meal were continued with special reference to the alfalfa meal produced by artificial hay-drying plants. Contacts were made with the State feed-control officials in order to obtain further information on the factors to be

considered in developing standards for alfalfa meal. A paper entitled "Problems in Alfalfa-Meal Standardization" was presented at the annual meeting of the Association of Feed Control Officials.

HAYSTACK MEASUREMENT

The tabulating and summarizing of the haystack measurement data collected in cooperation with 10 of the Western and Great Plains States during the season of 1927 and 1928 was completed. The Division of Farm Management and Costs assisted in this work. Formulas for determining the volume of several types of oblong stacks and a method of determining the volume of round stacks were developed. The average number of cubic feet per ton was determined for various kinds of hay and for different lengths of time in the stack. These figures, since they are based on data for a large number of stacks, can be used with the assurance that they will give fairly accurate results. The results of this study have been submitted for publication, and an article has been prepared for the 1931 Yearbook.

CURING SOUTH TEXAS HAY

Much of the hay produced in the prairie-hay section of south Texas is of low quality. Producers and dealers maintain that it is impossible for them to produce hay that has sufficient color for the No. 2 grade. A study was begun for the purpose of determining whether the hay deteriorates in color after it is stored or if the poor color is due to poor curing and late cutting. The samples cut during the early season seem to indicate that this hay has considerable color at that time. Bales are being stored and will be examined again during the winter to determine whether the color was lost in storage.

HAY-INSPECTION SERVICE

The hay-inspection service has shown a constant growth. Six new cooperative agreements have been made which extended the work into new territory, particularly in the alfalfa-producing sections in the West. Probably the most important of these is the agreement with the California Department of Agriculture, which provides for definite establishment of Federal-State inspection service in that State. An agreement with the Arizona Farm Bureau Federation now makes Federal inspection available at shipping points in the Salt River Valley, while other agreements provide for service in Utah and Idaho, and additional service in New Mexico. An agreement with the Atlanta Commercial Exchange by which all members of that exchange have all hay received by them at Atlanta inspected by Federal inspectors adds another large receiving market to the service, and a new agreement negotiated with the Oklahoma State Market Commission has resulted in the renewal of the agreement with that State which was discontinued about a year ago.

BROOMCORN INSPECTION

Three years' experience in the use of the broomcorn standards recommended by this bureau in 1927 has indicated that although they provide accurate specifications for quality, length, and other

factors affecting the grading of broomcorn, the process of analyzing the statements of the percentage of these factors when trading on that basis is too complicated for business purposes. A study has been made to find some method of summarizing the results of these detailed analyses by which they could be expressed in some general terms which would meet the requirements of the trade and at the same time be simple enough to secure more general adoption than the original standards. As a result, revised standards have been prepared and submitted to producers, dealers, and manufacturers for further consideration. Expressions received from the trade thus far are favorable to this new plan, and it is expected that they will soon be issued as the recommended standards.

BEAN STANDARDIZATION

Extensive tests were made on a modified moisture-testing machine, widely used in the bean industry, for the purpose of checking the results obtained with those of the official Brown-Duvel machine. These tests showed that the official machine showed a higher moisture content for a given sample than the modified machine. Data obtained in connection with the bean-inspection service were studied with a view of determining the accuracy with which the United States standards reflect the commercial quality of beans. As a result of these studies the United States standards for beans were revised. The changes made are designed to bring the standards more closely in line with local production problems, marketing methods, and consumers' requirements.

A series of conferences were held with large bean buying and selling organizations. A representative group of canners who use normally 70 per cent of the pea beans produced in the United States, after protesting against the quality of beans delivered under existing trade standards and rules of arbitration, endorsed the United States standards and Federal inspection and recommended their adoption by bean shippers' and jobbers' associations. A resolution embodying these statements was subsequently passed by the National Canners Association.

SOYBEAN INSPECTION

At the request of mills, the soybean-inspection service was extended to Atchison, Kans.; Sikeston and St. Louis, Mo.; Chicago, Ill.; and Cincinnati and Toledo, Ohio, necessitating the training and licensing of nine new inspectors. Licensed inspectors were also stationed at Kansas City and Buffalo. Mills in all of the more important soybean markets, except Decatur, Ill., are now buying soybeans on the basis of the United States standards applied by Federally licensed soybean inspectors. In all cases, however, the United States standards are the basis for soybean purchases and growers' contracts.

BEAN INSPECTION

The number of inspections of beans made during the year was 2,541, an increase of 70 per cent over that of 1929. The inspection service was established at St. Louis, Chicago, Pittsburgh, and Philadelphia in response to requests from buyers and trade organizations. It is more desirable from the standpoint of shippers that beans be

inspected at original shipping point; consequently, the number of inspections at terminal markets is small. This service was also extended to shipping points in California under a cooperative agreement with the California State Department of Agriculture.

DIVISION OF WAREHOUSING

H. S. YOHE, *in Charge*

The greatest growth under the warehouse act during the past year was in the licensing of grain warehouses, the licensed storage capacity for grain having increased more than 50 per cent over the preceding year. On July 1 more applications were pending for the licensing of grain warehouses than at any one time in the past. This increased demand for the licensing of grain-storage facilities was due to several factors, the principal ones being the condition of the grain market and a keener appreciation on the part of credit institutions of the Federal warehouse receipt as collateral for loans.

The licensed storage capacity for cotton also reached a new high mark, and indications were that additional warehouses for cotton would be licensed under the act during the coming year. Moreover, an increase in the demand for licenses by wool warehouses was noted, especially in producing sections.

A substantial increase occurred also in the licensed storage space for canned foods. This has been brought about by the credit needs of canners and by a desire of many canners to avail themselves of the grading service afforded under the warehouse act. Buyers of canned vegetables on a large scale have also played a part. In one instance a large chain store entered producing territory during the canning season and made its purchase of canned tomatoes on the basis of the grades for canned vegetables which were prepared under authority of the warehouse act. This company specified that all canned tomatoes purchased must grade in line with those standards. To secure the grading service they directed that all goods should be shipped to Federally licensed warehouses, where they were inspected immediately upon arrival. If they met the grade requirement they were placed in the licensed warehouse. If they did not, they were rejected.

CANNED-FOODS STANDARDS

Under authority of the warehouse act tentative standards have been prepared for canned peas, tomatoes, corn, string beans, Lima beans, spinach, and beets. First drafts of standards have also been prepared for canned peaches, hominy, carrots, and succotash. Standards for some of these products had been prepared in previous years, but they were perfected during the last year, with the result that they are coming into general use. Many canners are now packing their products on the basis of those standards, and wholesale merchants are buying to a considerable extent on the same basis.

AMENDMENTS TO REGULATIONS

The regulations for the storing of cottonseed were amended so as to permit the storage of cottonseed having a moisture content not in excess of 12 per cent in warehouses equipped with cooling and conditioning apparatus approved by the department.

The regulations for the storage of nuts were amended and revised, and the storage of pecans, filberts, and English or Persian walnuts was authorized.

The regulations for the storage of cold-pack fruit were amended to permit the storage of berries packed with one-tenth of 1 per cent of benzoate of soda by weight. Berries so packed are not required to be placed in sharp rooms, and they may be carried in storage at higher temperatures than the ordinary cold-pack berry covered in the regulations prior to the amendment.

COTTON WEIGHING

Work in the weighing of cotton stored in licensed warehouses, for the purpose of checking the accuracy of weights, was continued. As a result, more care is being exercised by warehousemen and licensed weighers, and complaints regarding the weight of cotton passing through licensed cotton warehouses are decreasing.

EXPANSION OF SERVICE

On August 1, 1929, a cooperative agreement was entered into between this department and the Alabama State Department of Agriculture for the administration of both State and Federal acts in the State of Alabama.

On account of the increased demands in the West Plains area, that area was made into two divisions and a new office established at Omaha. A great number of applications for the licensing of grain elevators have been received in the closing two months of the year. A number of elevators of a capacity of a million bushels or more, located in this area, have already been licensed, and further applications are pending.

STATISTICAL AND HISTORICAL RESEARCH

O. C. STINE, *in Charge*

The general world-wide financial and business depression has seriously affected the markets for farm products at home and abroad. The average price received by producers, computed for about 30 farm products, dropped from 143 per cent of pre-war prices in August, 1929, to 111 per cent in July, 1930, although the total volume of crops produced was smaller than during the preceding year. The decline in farm prices was due mainly to a decline in the general price level, a reduction in the buying power of consumers, and consequently a world-wide reduction in the demand for farm products. This marked decline in farm prices in the face of smaller supplies for market greatly increased the demands for economic analysis and for appraisals of the outlook for the several important farm products.

Analysis of current conditions and the meeting of emergency current demands for data have occupied a very large part of the time of the staff. The Federal Farm Board early in the season requested data as to the economic situation and outlook for several of the farm products as a basis for determining loan policies. The sharp break in prices in November stimulated many demands for an analysis of the situation with respect to important commodities. Special efforts were made to present the facts about the cotton situ-

ation to farmers in time to be used by them as a basis for determining the acreage that they should plant in the spring. This division participated more fully than ever before in presenting the outlook to producers in many parts of the country. Toward the end of the season a special effort was made to appraise the wheat situation and outlook as a basis for a program of planting for the 1930-31 season. In addition to these special cases, many Members of Congress, executives, and private citizens made urgent requests for facts concerning the tariff and analyses of the probable effects of tariff changes upon the prices of farm products.

The extent and seriousness of the business depression became an important problem early in the season. Some decline in business had been indicated in the outlook report for the 1929-30 season. As the season progressed much attention was given to a study of factors affecting business to obtain a measure of the extent and probable duration of the business depression, and the probable effect of the business depression upon the demand for farm products. This study showed that the business situation has been reflected quite definitely in the general level of wholesale food prices. Since 1920 the combined prices of food products, particularly prices of meats and dairy products, have fluctuated very much like the variations in domestic business as reflected in factory pay rolls. Although variations in supplies are partly responsible for the price movements, the changes in buying power of consumers have exerted a very important influence. The decline in the prices of meats and dairy products, amounting to more than 15 per cent between the spring months of 1929 and the summer of 1930, may be attributed very largely to the decline in the buying power of consumers, inasmuch as the supply situation had not changed materially during this period.

Some preliminary studies have been made of the effect of the business and general price-level depression upon returns to farmers. It was found that farmers received considerably less for their marketings of cattle, hogs, and lambs because of the reversal in the business situation. For example, in April, 1930, producers received from packers approximately \$12,000,000,000 or about 15 per cent less than they probably would have received for the same quantity marketed in the early part of 1929. The late-potato crop of 1929, because of the lower level of food prices and business in general, was marketed for about 10 cents per bushel less than the prices that might have prevailed had there been no decline in the business situation. In the early spring and summer months of 1930 the marketings of the early-potato crop brought 30 to 50 cents per barrel less than farmers would have received under normal business conditions. A preliminary study of cotton indicated that the general financial and business depression had been responsible for reducing the demand for that staple sufficiently to lower the price nearly 2 cents per pound below what it would have been otherwise in the spring of 1930.

The relation of financial and business conditions to farm expenses also received attention. It was found that the prices farmers pay have declined to some extent, but not nearly so much as the prices of farm products. The prices paid for fertilizer appear to be determined by the area to be fertilized as well as the purchasing power of producers. Farm wages have been reduced slightly under the in-

fluence of increased unemployment in cities. The index number of prices farmers pay for commodities purchased has declined from 155 in July, 1929, to about 149 in July, 1930, or 4 per cent. Farm wages declined from 173 to 160, or 8 per cent, in the same period, quite in contrast to the drastic decline in farm-product prices. The ratio of farm-product prices to the prices farmers pay for what they buy declined from 90 to 74 per cent of pre-war prices.

POTATO PRICE ANALYSIS

The interstate potato committee has been supplied with current analyses of the potato situation. Statements have been delivered at meetings of bankers, dealers, and growers on the Eastern Shore of Maryland and Virginia and in Florida. These statements covered production, the effect of changes in production, marketings, and business conditions on the seasonal level of prices and probable seasonal trends. An analysis of potato prices has been completed, and the results will be published.

The outstanding facts to be presented in the potato price bulletin deal with (1) changes in the annual level of prices for the country as a whole and for important surplus and deficit areas, (2) seasonal variations in potato prices on the Chicago market, (3) the effect of prices on marketings, and (4) the effect of prices on acreage changes in the following season.

The largest element in the yearly variations in price for the country as a whole was found to be the volume of production. The annual prices in most of the important producing areas are influenced by the national supply, so that once the national supply or the probable national price level is known, the probable prices in these areas are readily indicated. The importance of the national factors as elements in local price appears to be least in the far Western and greatest in the Central States.

Price appears to be a factor in the volume and rate of marketings of a crop already produced. Given an average crop, more will be sold during the entire season when prices are high than when prices are low. The percentages of average crops sold under varying price conditions differ in the important areas. In very low price years only 35 per cent of the Wisconsin crop has been sold, 50 per cent of the Michigan crop, 65 per cent of the Idaho crop, and 75 per cent of the Maine crop, but in years of high prices 60 per cent of the Wisconsin crop has been sold, 70 per cent of the Michigan crop, and 85 per cent of the Maine and Idaho crops.

The total supply of potatoes in any one year is apt to be determined as much by changes in acreage as by changes in yield. For the country as a whole a price level of about \$1 per bushel tends to keep acreage constant from one season to the next. Prices below that level tend toward acreage reduction, whereas higher prices stimulate increase in acreage. Very low prices received for a crop not only result in acreage reductions in the following year but also in the second year following the season of low prices.

ORANGE PRICES

A study of orange prices was begun as a joint project with the New York University cooperating through the New York Food Marketing Research Council. The purpose of the study is to analyze (1)

the influence of the supplies of oranges and competing fruits, the grade and size of oranges, and the trend of demand for oranges, on the returns for the crop, and (2) the effect of similar supply and other factors on market returns for short-periods in a particular market. The demand for oranges has increased very rapidly in the United States during the last 10 years. This has made possible the marketing of increasing crops at prices equal to or above those obtained in preceding years. There is indication of a slackening in the rate of increase in demand at the present time. It has been found that the chief factors in the prices of oranges are total supply, the quality of the crop, the average size of the oranges, the concentration of shipments, and the competition of other fruits. The analysis of weekly receipts and prices in New York indicates the outstanding importance of supply, competition of other fruits, and temperature, and the detailed analysis of daily supplies shows clearly the influence of changes in size and quality upon orange prices. It is planned to complete this study and publish results during the coming year.

TOBACCO PRICES

Studies of factors affecting the acreage and price of the various types of tobacco were inaugurated. It was found that for the period from 1921 to 1929 approximately 35 per cent of the yearly variations in the price of flue-cured tobacco were associated with variations in supply, 25 per cent with variations in quality, and 14 per cent with the regular growth of demand. An analysis of the prices on different markets indicated regular seasonal variations in the prices of this type of tobacco. On six representative markets in North Carolina during the seasons from 1925-26 to 1928-29 prices, on an average, advanced 28 per cent from September to October, advanced 9 per cent from October to November, declined 15 per cent from November to December, and declined 12 per cent from December to January. The changes appeared to be due largely to the quality of the marketings, a larger proportion of the better grades being sold during the middle of the season. It was found that 88 per cent of the yearly changes in the production of flue-cured tobacco since 1909 was due to variations in acreage and 12 per cent was due to variations in yield per acre; in the case of Burley 78 per cent of the yearly changes in production was due to variations in acreage and 22 per cent to variations in yield per acre; for Kentucky and Tennessee fire-cured tobacco, 96 per cent of the variations in production was due to variations in acreage and 4 per cent to variations in yield per acre.

Studies of the factors affecting the acreage of the different types of tobacco indicated that the prices received by growers the previous year, and the second year previous, as well as the acreage change the previous year are important in determining the acreage planted.

A study of the factors affecting the acreage and prices of cigar tobacco grown in the Connecticut Valley and competing cigar types was undertaken in cooperation with the Connecticut Agricultural Experiment Station. A feature of this study has been the analysis of the records of the Connecticut Valley Cooperative Tobacco Association, in which the prices by grades are used for a 3-year period. The results of the analysis were used in the bureau's price-situation and outlook reports. Four reports were prepared during the marketing season, each summarizing the supply and demand conditions

for the different types of tobacco and indicating changes in the market prospects. Special outlook statements were prepared for flue-cured and Burley tobacco, which were used extensively by State and Federal extension agencies and the Federal Farm Board in efforts to acquaint all growers with the unfavorable market prospects for these types before the crops were planted.

RICE PRICES

The project, factors affecting rice prices, was completed during the year and a report prepared. The following prices were analyzed: Fancy Blue Rose at New Orleans, yearly average and monthly prices; rough rice in Louisiana, farm price as of December 1; Fancy California-Japan at San Francisco, yearly average price; Japan variety, middle quality brown at Tokio, yearly average price. Based on these analyses, a forecast was made in November, 1929, of Fancy Blue Rose prices for the months December, January, February, March, and April, with the following results: December, correct; January, 0.6 per cent error; February and March, correct; and April, 1 per cent error. A forecast made in October of rough-rice prices in Louisiana as of December 1 was less than 1 per cent in error. The effect of price on acreage changes in both the southern belt and California was determined. It was found that price alone in neither case was sufficient to explain acreage changes. In California, price, together with an index of water available for irrigation, gave satisfactory results. The results of this study have been presented to rice growers in the South and have received their endorsement.

STOCKER AND FEEDER CATTLE

An economic study of stocker and feeder cattle, with special emphasis on the factors affecting price, was begun. The price of Good to Choice feeder cattle 800 pounds up at Kansas City was the price series used in most of the analyses. It was found that the factors affecting prices change in different seasons of the year. Even those prevailing throughout the year vary as to importance. Four separate studies were made, each covering a 3-month period in which similar conditions prevail. The results of these analyses are being prepared for publication. They serve also as a basis for the bureau's forecasts of future prices and conditions in the livestock industry.

A study was made of the variation in live weight of stocker and feeder shipments, and of cattle slaughtered. It was shown that there has been a definite downward trend in the weight of stocker and feeder cattle during postwar years, but that there had been no corresponding trend in weights of cattle slaughtered. The relation between prices of heavy and light slaughter cattle was worked out.

The period of heaviest stocker and feeder shipments is during the fall months, and the heaviest marketing season for fat cattle is during the summer. Since 1921, stocker and feeder shipments from October to December were found to be closely associated with marketings of fat cattle at Chicago from April to August, except during years of low corn prices. The study indicates that if the farm price of corn in April is below 75 cents more cattle are sold for slaughter at Chicago, and the lower the price the greater the slaugh-

ter, when feeder shipments the previous fall are held constant. Corn prices have no noticeable effect if they are above 75 cents per bushel.

A corn-hog ratio for the Corn Belt was constructed, covering the period from 1922 to 1929, for use in relating changes in hog supplies to changes in the corn-hog ratio. This ratio was used in studying the market situation for corn and for hogs, and in forecasting the number of hogs which would be slaughtered during the coming season.

Much statistical and analytical work was done in connection with the various reports on the agricultural situation. Supply-price curves for hogs, cattle, and sheep were constructed for publication in the 1930 Yearbook of Agriculture and for use in the work of forecasting future conditions.

TEXTILE PRICES

Research with reference to the prices of textiles has continued. The most important development of the year has been the assembling and analyzing of world wool production and price statistics, by grades, from 1890 to date. The analysis of wool production and prices shows very clearly that there are definite cycles in wool production. Furthermore the study has shown that it is necessary to consider fine wool separately from medium or coarse wools, since the cycles of production and prices of these wools differ. The results of this study will make it possible for producers to understand better the shifts that are taking place and to avoid making changes which in the long run may not prove profitable.

Cotton-research studies undertaken during the year include revision of world-production statistics, classification of foreign growths by staple, developing an index of cotton-production costs, and the collection of data for analyzing foreign demand for cotton. Monthly reports on world wool prospects and world cotton prospects have been issued as well as a quarterly report on the world carpet-wool situation.

DAIRY AND POULTRY RESEARCH

This division joined the division of dairy and poultry products and the New Jersey Agricultural Experiment Station in making a study of the production and consumption of dairy products in New Jersey. Six townships, largely rural, and selected districts in metropolitan New Jersey were surveyed. The survey of the rural townships has been completed. In these rural communities it was found that the availability of milk was an outstanding factor in determining the quantity of milk consumed. Income is also an important factor in milk consumption. It was found that per capita consumption of dairy products declined as per capita income decreased. The survey of the consumption of dairy products in metropolitan New Jersey has been completed. This survey obtained data from 2,200 families which will be analyzed to show the effect of income, race, and size and composition of family upon per capita consumption in cities.

In cooperation with the New York Food Marketing Research Council an analysis is being made of the effect of income and other conditions upon the consumption of butter and eggs in New York City.

In cooperation with the Division of Dairy and Poultry Products and the Maryland Agricultural Experiment Station a survey of the consumption of dairy products in Baltimore was begun.

Some progress has been made in analyzing poultry and egg prices. It has been determined that there is a definite regular 3-year cycle in the monthly prices and receipts of both eggs and poultry. A definite relationship has been found between fall poultry receipts and egg receipts the following spring. The study is continuing with the object of making a comprehensive analysis of poultry and egg prices.

GRAIN-PRICE ANALYSIS

Statistical researches relative to grain have continued along many lines. Analysis of weather in relation to yields as a basis for making early forecasts of crops in important competing countries has been continued. During the last season forecasts of production in Canada, Argentina, and Australia have been fairly accurate. Each season, however, presents problems peculiar to the season and requires careful analysis of the special features that develop in the course of the season.

At the beginning of the last season a wide spread between cash prices and distant futures in the markets of the United States, and between prices in the Canadian and United States markets brought a demand for interpretation of the situation. A careful study of the factors entering into the situation indicated that congestions at terminal markets resulting from a large carry-over of old wheat and heavy early marketings were a very important factor in depressing cash prices of wheat in the principal markets of the United States.

Observing the effect of congestion at terminal markets upon cash prices, plans were made to watch the situation carefully throughout the 1930-31 marketing season. A survey of storage capacity was made in cooperation with other units of the bureau, and one worker, was assigned to the task of putting together and keeping up to date all information bearing upon the movement of the wheat crop, so that the Farm Board or any other agency interested might make plans to prevent congestion in the terminal markets during the movement of the 1930-31 crop.

DIVISION OF FOREIGN AGRICULTURAL SERVICE

ASHER HOBSON, *in Charge*

In order to make estimates of price prospects for American agricultural products the department needs accurate knowledge of the world situation in regard to acreage sown, crop conditions, stocks on hand, numbers and kinds of livestock, and prices, together with an appraisal of present and prospective demands. The prices of a greater portion of the farm commodities grown in this country are affected by conditions abroad, and those definitely on an import or export basis are most sensitive to the impact of foreign economic forces. Of those on an export basis, cotton, grain (principally wheat), tobacco, pork products, apples, and dried fruit are outstanding. The more important items commercially grown in this country, but of which large quantities are also imported, are sugar, wool, flaxseed, and nuts. To these lists should be added dairy products, beef, mutton, and lamb, which do not fall definitely into either the

export or import class but which, during periods of over or under production, must cope with foreign competitors.

Many Governments fail to report statistically upon the agricultural activities of their countries. In some cases the information available is expressed in terms which make it difficult to compare conditions in different countries and in previous periods. Hence, there remains the essential task of supplementing the existing data by observations of trained investigators. This work, together with the interpretation of existing data in terms of prospects for American agriculture, is essential as a basis for sound production and marketing programs in this country.

In order to meet this need, the last Congress enacted legislation designed to expand in a substantial manner the foreign-service activities of the Department of Agriculture. This act is entitled: "An act to promote the agriculture of the United States by expanding in the foreign field the service now rendered by the United States Department of Agriculture in acquiring and diffusing useful information regarding agriculture, and for other purposes." (Public No. 304, 71st Cong.)

For the purpose of putting into effect the provisions of this act, the Division of Foreign Agricultural Service has been established in the Bureau of Agricultural Economics. The activities of this division are designed to provide an adequate world-wide production and market outlook service for American agriculture by collecting more accurate and more extended information upon world conditions of agricultural production, competition, and demand with a view to furnishing a more reliable basis for production adjustments and marketing policies in the United States.

In the dissemination of foreign information the regular informational services of the bureau are used wherever possible. Much of the current information received by cable is forwarded by leased wire to the bureau's market-news offices throughout the country. The weekly publication *Foreign Crops and Markets* is being continued. The former foreign-commodity news releases have been replaced by monthly statistical reviews of world-wide conditions with respect to a number of the principal agricultural products. Other divisions of the bureau cooperate in the foreign-service work.

At the close of the fiscal year the bureau maintained resident representatives in London, Berlin, Shanghai, and Marseilles. Shortly thereafter a resident representative was stationed in Belgrade to cover the Danube Basin. Preparations are under way for maintaining resident agricultural representatives in South America, South Africa, Australia, India, and the Scandinavian countries. In addition to this resident staff located in foreign countries, it is planned to secure the services of a number of specialists who will give their attention to the world situation with respect to specific commodities. For these positions the department intends to employ men who are conversant with the international situation in cereals, cotton, tobacco, wool, fruits, livestock and meats, and dairy products. These men will be assigned to work on specific commodities rather than to territories and are expected to constitute a mobile force working in close touch with the foreign field staff and with the commodity divisions of the Bureau of Agricultural Economics in Washington.

Special attention is being given to coordinating this work with similar activities of the Consular Service of the State Department and with those of the foreign representatives of the Department of Commerce. To this end a liaison committee has been created. This committee consists of one representative each of the Department of State, the Department of Agriculture, the Department of Commerce, and the Federal Farm Board. This committee is in position to facilitate the coordination of effort between the departments concerned and insure more adequate services in the field to be covered.

DIVISION OF AGRICULTURAL FINANCE

ERIC ENGLUND, *in Charge*

SHORT-TERM CREDIT

Research in short-term agricultural credit has been concerned chiefly with credit conditions among farmers in the South; the relation of credit advances to potato production in the Eastern Shore of Virginia; and the success of agricultural-credit corporations in financing farmers and facilitating the work of cooperative-marketing associations in the Cotton Belt.

The studies of credit conditions among southern farmers have been conducted in cooperation with State agricultural experiment stations. Two bulletins, *Credit Problems of Cotton Farmers in Butts and Laurens Counties, Ga.*, and *Farm Credit in North Carolina—Its Cost, Risk, and Management*, were published by the agricultural experiment stations of Georgia and North Carolina, respectively. The results of a similar study covering credit problems of farmers in Oklahoma will be published by the Oklahoma Agricultural Experiment Station.

All of these studies show that the use of merchant credit is widespread among southern farmers and that this type of credit is extremely costly. They also indicate clearly that the economic position of many southern farmers must be strengthened considerably before any marked improvement in credit conditions can be effected. Nevertheless there is indication that the limited supply of current funds, which in some areas is partially responsible for the high cost of credit, might be employed more effectively if farmers were to make greater use of existing mortgage-credit facilities. A summary of the results of all southern studies made in recent years is being prepared.

The study in the Eastern Shore of Virginia is being conducted in cooperation with the Division of Farm management and Costs of this bureau and the Virginia Agricultural Experiment Station. In its larger aspects this study is concerned with the causes of excessive potato production, the effects of price depression, and the possibility of adjusting production more closely to demand. This division is analyzing the possibilities of bringing about better adjustment through credit control.

No conclusive results can be presented now, as the work has not advanced beyond the gathering of basic data. A preliminary survey of data indicates that any control local bankers might be inclined to exercise would be rendered in large measure ineffective by the liberal credit terms offered by dealers and merchants.

In the study of the success of agricultural-credit corporations in financing farmers, the operations of five agricultural-credit corporations which serve as auxiliaries to cooperative-marketing associations have been analyzed. Separate reports on three of these corporations have been prepared, and a consolidated report on all is in state of preparation. This work has been carried on in cooperation with the division of cooperative marketing of the Federal Farm Board.

The results may be summarized as follows: In no case has the 2 per cent spread between the rediscount rates of the Federal intermediate credit banks and the rates which corporations were permitted to charge, sufficed to cover operating expenses and losses and to provide for satisfactory dividends and surplus accumulations. (2) In most cases the corporations have been a source of heavy expense to the parent cooperative-marketing associations. (3) The corporations have been operated at least cost to the parent associations and to borrowing members when they have had relatively small territories, large-sized loans, and borrowers who are good risks. (4) The extreme seasonality of business has been one of the causes for lack of profit to the corporations. (5) The value of the corporations to the associations is problematical. It does not appear that the value of the service of securing additional deliveries of cotton has offset the cost of the corporations to the association. Yet the advantages to members arising from the additional credit facilities provided by the corporations, may be very great, and may, in turn, strengthen the position of the marketing associations. It has not been possible as yet to get an accurate measurement of these services.

FARM-MORTGAGE CREDIT

A thorough analysis of the farm-mortgage debt situation has been summarized in a manuscript for publication on farm mortgages in the United States. This study, in addition to presenting estimates of farm-mortgage debt, analyzes the various problems faced by the farmer as a result of the increased volume of mortgage debt. The results show that the frequency of debt on farms in the United States has increased from 34.8 per cent in 1925 to 36 per cent in 1928. The study reveals the further significant fact that 12.2 per cent of all farms mortgaged carry a mortgage debt of over 75 per cent of their value. The difficulty of repaying the farm-mortgage debt under different price levels is discussed, and the most effective methods for eliminating the hazards as to renewals and high interest payments are presented so as to enable the farmer to adjust his financial problems in a more efficient manner.

The results of this study show that there have been important shifts in the relative importance of mortgage-lending agencies. Insurance companies have by far the largest amount of farm-mortgage loans, with 22.9 per cent of the total outstanding loans in 1928. Federal land banks are second in importance with 12.1 per cent of the total, while State and national banks, which until after 1921 were of first rank, now appear in third place among institutions, with 10.8 per cent of all debt. Mortgage bankers have 10.4 per cent, retired farmers 10.6 per cent, and active farmers only 3.6 per cent. These studies have thus revealed a pronounced tendency for the

farmer's long-term financing to shift toward stronger and more specialized agencies, which as a whole offer longer terms and lower interest rates.

The estimate of the farm-mortgage debt contained in the above study represents the completion of the first part of the program for providing current data on the farmer's finances. The data obtained records the movement of capital into agricultural areas and provides the basis for compiling indexes of the rate at which farms are being mortgaged and the rate at which they are being cleared of debt. These series will supplement indexes of bankruptcies and foreclosures already set up.

Construction of indexes of security prices for Federal and joint-stock land-bank bonds has indicated that the difficulties of the joint-stock branch have been reflected in a relative depreciation in Federal land-bank bonds. The increase in the volume of foreclosed lands acquired by the land banks has materially increased the difficulties involved in marketing their bonds at an advantageous price.

The importance of the country bank as an agency in financing the credit requirements of the farmer is generally recognized. It has been difficult, however, to obtain any definite measure of their ability to meet loan requirements of the farmer customer. A general measure of their ability to finance agriculture has been obtained by compilation of an index of demand deposits for member banks of the Federal reserve system located in towns under 15,000 population. This index covers 20 agricultural States, and the composite series is weighted by the proportion of the cash value of their agricultural output. The index represents monthly data computed for the period of 1923 to 1928.

Work was begun on three major projects dealing with the following subjects: Changes in interest rates and their relationship to farm-mortgage financing; the influence of short-term interest rates upon the availability of agricultural credit for production purposes; and the influence of monetary factors on the fluctuations of the wholesale price of farm products.

A valuable step toward economy and efficiency was taken by combining the two annual questionnaires concerning taxes and credit practice. The result has been a marked saving in time, effort, and money. A number of articles have been contributed to scientific journals, and a number of radio talks on farm credit have been given. Much of the material compiled has been utilized in connection with agricultural extension work upon a number of occasions.

AGRICULTURAL INSURANCE

A study has been made of the history and present status of live-stock insurance in the United States, including an analysis of the various problems involved in providing such insurance protection for the farmer. This bureau has received many requests for information upon this subject, but comprehensive information has been almost entirely lacking. Material obtained through this study is being prepared for publication.

The development of livestock insurance in the United States has been relatively slow as compared with progress in European countries. Prior to 1911 a few commercialized stock-insurance companies

and a score of mutuals, most of them in the Middle Atlantic States, wrote livestock insurance. During the decade 1911-1920 about 30 commercial companies and 25 mutuals entered the field. The majority of these new companies were organized during the years of high livestock prices brought on by the war. However, all but one of the commercial insurance companies writing livestock insurance exclusively, and a number of mutual companies in this group have since dropped out. Most of the remaining mutuals, some of which have been in existence over 50 years, have lost ground during recent years. This is in part explained by the continued low value of horses which in many cases comprise the bulk of the business. Better prices for farm animals, particularly horses, and improved farm incomes would no doubt cause a renewed demand for livestock insurance.

Special attention has been given to the problem of fire losses on the farm and to the prevention and control of farm fires. Some of this work was done in cooperation with a committee on farm fire protection working under the auspices of the National Fire Protective Association. A farmers' bulletin on Fire Safeguards for the Farm was prepared in cooperation with the Bureaus of Chemistry and Soils and Public Roads. This bulletin deals in a simple and popular way with the threefold problem of measures for preventing accidental fires, of simple home equipment for the prompt extinguishment of the fires that are discovered in their incipency, and of organized rural fire protection.

Additional information has been gathered on farmers' mutual fire and windstorm insurance and on crop insurance, more particularly against hail. A study of employers' liability insurance for farmers was begun.

Addresses on various phases of agricultural insurance were delivered during the year before many of the National and State mutual insurance associations. Several articles dealing with farm insurance problems have been contributed to insurance journals.

FARM TAXATION

The results of research in farm taxation, conducted in cooperation with a number of States, were summarized and published in the last year as Technical Bulletin No. 172, Taxation of Farm Property. This bulletin has been well received by farmers, their organizations, and the public generally. Results of other phases of the bureau's investigations in this field have appeared in papers, addresses, and material for the press.

The work of ascertaining the trend of farm taxes in various States and sections of the country has been strengthened. Reports were received from 17,000 farmers giving the value of the property and taxes paid and other information which made it possible to determine changes in taxation. The average tax per acre in 1929 was 7 per cent above 1924 and 150 per cent above the per acre tax in 1913-14.

The relation of taxes to land values was ascertained. It was found that in the country as a whole taxes in 1929 were 1.47 per cent of full value of the real estate, as compared with 1.22 per cent in 1924, and 0.68 per cent before the war. This increase in the true tax rate, i. e., taxes on full valuation of property, is due not only to the increase

in taxes but also to the decline in land values. It is estimated that at the present time taxes paid on farm real estate equal the interest which farmers would pay at 6 per cent on a mortgage indebtedness amounting to one-quarter of the full value of farm real estate.

Although problems of adjustment in farm taxes lie largely within the sphere of the States, since these taxes are levied by State and local authorities under State law, the bureau can render important service to agriculture and to the Nation generally by research in this field. The results not only call attention to the farmers' tax problems, but also help to determine and explain the causes and the economic effects of increasing farm taxes, and thus help to lay a foundation for sound programs of adjustment in State and local taxation.

DIVISION OF FARM POPULATION AND RURAL LIFE

C. J. GALPIN, *in Charge*

An increasing interest on the part of the public in the group phases of the human factor in farm management has been manifested by more demands upon this bureau for information. For example, public utilities have made inquiries with regard to the group use by farmers of electricity; advertisers have requested information with regard to farmers' standards of living and the purchasing power of farmers; and constant inquiries have been received with regard to movements of population to and from farms, and the economic significance of such movements. There has been an urgent demand also for information on the social aspects of the farmers' cooperative enterprises. The Division of Farm Population has endeavored to furnish authentic information on these questions in so far as such information is available, and to carry on research for the purpose of obtaining dependable data which will bring about a better understanding of the farm problems.

FARM POPULATION MOVEMENTS

A survey of the movement of population to and from farms during the calendar year 1929 indicated that the farm population was still declining in absolute numbers through migration to towns and cities. Data are available covering the decrease of farm population over the last 10 years, but it is not yet possible to state whether the bottom of the decline has been reached. A cooperative study of farm migration in selected communities in the State of Washington was completed recently, and the results published by the Washington Agricultural Experiment Station. Similar studies are under way in Iowa, Missouri, Vermont, North Dakota, and Montana. Special articles have been prepared for publication covering trends in farm-population movements.

RURAL MERCHANDISING PROBLEMS

A study in Minnesota, in cooperation with the Minnesota Agricultural Experiment Station, on the services of rural trade centers in the distribution of farm supplies indicates inadequacy in present merchandising methods of country and village stores. Slow adjustment of mercantile ways to the changing conditions of modern life appears. Problems arise in connection with volume of sale, mark-up,

grade of goods, advertising (informing the farmer), credit, plant, and equipment. Improvement in rural merchandising seems to call for one or more of the following changes: (1) Retaining existing agencies but strengthening their merchandising practices; (2) retaining local trade agencies but joining them into chain units, either of a proprietary or cooperative nature; (3) concentration of local merchandising functions into fewer units and in larger trade centers; or (4) organization of consumers into cooperative-buying units, either local or federated. This study emphasizes the fact that the spending of the farmer's dollar efficiently is contingent upon the reorganization of the whole rural merchandising system.

A somewhat similar study in New York State, made in cooperation with the Cornell University Agricultural Experiment Station, on village service agencies for New York State as a whole indicates that villages below 500 in population are losing out as trade centers, cultural centers, recreational centers, and social centers for farmers. In urban counties it takes a village of from 1,250 to 1,500 population to maintain the service agencies found in a village of from 1,000 to 1,250 in rural counties because of the trade magnetism of the cities in the urban counties.

A study in Oklahoma, in cooperation with the Oklahoma Agricultural Experiment Station, on the relation of town and country interests in Garfield County indicates that the city of 17,000 population in the county (Enid), on account of good merchandising methods, is competing strongly with the farmer's villages and towns for farmer trade. Apparently, the small trading posts are being subjected to great strain to fit into the farmer's needs.

These three studies in different parts of the United States indicate basic rural social changes going on in the facilities for meeting the farmer's increasing standard of living. The small village is giving place to a more adequate trading center.

FARMERS' ATTITUDES TOWARD ORGANIZATIONS

An important study in Ohio, in cooperation with the Ohio State Agricultural Experiment Station and informally with the Ohio State Farm Bureau Federation, on the attitude of farmers in Ohio toward cooperation, is nearing completion. This study illustrates the significance of knowing what farmers are thinking about their organizations, and about the policies of officials. The results of this and other studies indicate a sharp division of opinion as to the policies and functions of organization officials. Certain farmers are highly critical of their organizations on the ground that the administration is carried on by a few men without regard to the opinions or judgments of individual units. The criticism is not that officials decide actions and policies, but that the units are not consulted as to actions and policies. In other words, the farmers themselves have no voice through representation in what goes on at the top. The situation, therefore, is one of basic conflict between two philosophies of business, that of the big business oligarchy and the democratic cooperative ideal. Special articles and addresses have been prepared on social factors in membership relations, membership responsibilities in successful cooperation, and similar subjects.

INSTITUTE OF METHODS IN RURAL SOCIOLOGICAL RESEARCH

Research workers in the field of rural sociology during the week December 31, 1929–January 4, 1930, gathered at the bureau for a short school of methods in research. Sixty men and women from 36 colleges, universities, and institutes, in 24 States, Canada, and China were present. Research studies on population, standards of family living, and social attitudes were given special attention with respect to scope and methods.

RURAL COMMUNITY BUILDINGS

A study was completed and a bulletin published on rural buildings for business and social uses. Studies have been made also and articles prepared on rural planning in the interest of farm communities, the country library, farm fire protection, rural community clubs, contacts in a rural community, and other subjects.

DIVISION OF LAND ECONOMICS

L. C. GRAY, *in Charge*

A great deal of time has been devoted to cooperation with the Bureau of the Census in the preparation of the agricultural schedules to be used in the 1930 census and in helping to plan the program of tabulation and publication in such manner as to be of greatest service to the Department of Agriculture and the State experiment stations.

The bureau was also called upon by the War Department to participate, in cooperation with other bureaus of the department, in a land-appraisal study in the lower Mississippi Valley involving an area of over 4,000,000 acres. This project was undertaken in connection with a flood-relief program.

Special research has been carried on in matters pertaining to farm relief, and the relationship of land and land policies to the agricultural surplus.

Considerable time has been devoted to working out a program of land utilization and classification and to presenting the results of the bureau's work at various gatherings in different parts of the country. Many addresses given by members of the staff have been published in bulletin or book form by universities and various associations.

LAND RESOURCES AND LAND UTILIZATION

A study entitled "Regional Changes in Farm Animal Production in Relation to Land Utilization" has been completed and the results published. This study covered the effects of the tractor and automobile, and of increasing efficiency in production of meat and milk, upon the need for farm land in the principal agricultural regions. The publication has been used by the extension services in several States in planning programs of work, and by teachers in agricultural colleges.

The Atlas of American Agriculture, which has been issued in sections during the past decade, is now ready for publication in a single volume. This atlas, the responsibility for which has centered

in this division, brings together basic information on climate and soils, grazing land and forest lands, assembled by the Weather Bureau, the Bureau of Chemistry and Soils, and the Bureau of Plant Industry, the Forest Service, and other agencies. This atlas will be a major source of information on the physical basis of American agriculture for a half century or longer.

The Graphic Summary of American Agriculture, which is a compilation of 350 maps and graphs, showing the regional distribution of agriculture in the United States and the geographic shifts in crop and livestock production, in land utilization, land values, taxation, tenure, labor, and farm population that have taken place since the World War, has been prepared for publication. Previous editions of this Graphic Summary have provided many of the illustrations for textbooks on geography and the agricultural sciences, and the publication has been extensively used in agricultural colleges and State universities.

A publication entitled "Land Utilization and the Farm Problem" has been prepared which shows graphically those changes in land utilization and agricultural efficiency, on the one hand, and in diet and population trends, exports and imports, on the other hand, which indicate the urgent need of a new national land policy and of further research as an aid in determining that policy.

LOCAL LAND UTILIZATION AND REGIONAL-PLANNING STUDIES

In cooperation with the Vermont Agricultural Experiment Station and the Vermont State Department of Forestry, a study on problems of land utilization in the hill towns of Vermont has been made. Information bearing on the present utilization of land in the 13 towns studied has been utilized by a special committee of the comprehensive survey of rural Vermont in its report on forestry and the wood-using industries.

In addition, it has been possible to work out a preliminary plan for the complete economic and social reorganization of 1 town. Similar data are to be utilized to work out reorganization programs for the entire territory covered by the 13 towns. Since the towns are representative of a much larger territory in Vermont the program should have a very broad application. The social and economic problems of the "hill" towns are acute, and the results of the present study are timely and helpful in the development of a comprehensive program.

A similar project, in cooperation with Pennsylvania Agricultural Experiment Station, was continued. Data for Wyoming County are being published by the Pennsylvania station. The conclusion is reached in this bulletin that there are at least two large districts that are nonagricultural. The utilization of these districts for timber production is recommended. Moreover, in view of the local demand for mine props as well as for larger timber, it would be profitable on most farms to take better care of the farm wood lot. A small number of farms were carefully studied and described to show how the present systems of farm management and land utilization may be improved.

The intensive study of Tioga County, begun in 1928, will be completed during the year 1930. The results of these studies will

probably prove of particular value to the extension forces of the college in formulating programs for promoting the abandonment of districts found unsuited to farming, the development of forests in such districts, and the institutional readjustments made necessary by these changes.

A study has been carried on in eastern Kentucky in cooperation with the State Agricultural Experiment Station, and a manuscript has been completed entitled, "Farm Management and Incomes of Farm Families in Laurel County, Ky." This survey has provided a basis for a revision of the extension program in the area. Another manuscript, *Cost of Living and Population Trends in Laurel County, Ky.*, based on the same study, was also completed. A third manuscript is in preparation, *Problems of Land Utilization in Laurel County, Ky.* This bulletin will include a classification of land from the standpoint of best economic uses, and will consider the effects of such use on the distribution of population.

A survey has been made in West Virginia, in cooperation with the West Virginia Agricultural Experiment Station, and results have been prepared for publication. The study was pointed specifically at the separation of potential farming districts from potential forestry districts.

Plans have been under consideration for an economic and social survey of the southern Appalachians. This project will involve the cooperation of a number of the State experiment stations, and probably two other Federal bureaus. Its object is to develop an economic and social program for agriculture in the area.

LAND-SETTLEMENT STUDIES

A survey of the economic aspects of land settlement in the Great Lakes States (Wisconsin, Minnesota, and Michigan) has been completed. An analysis of data obtained in 1920 and again in 1928 for farms in 46 settlements, representing various types of land-settlement projects in the cut-over regions, led to the conclusions that, although settler turnover is due to many causes, a high percentage of turnover in any community is usually associated with intensive colonization practices or excessive promises by the company selling the land.

As a first step in the establishment of a public service on land-settlement questions, an effort was made to gain the cooperation of active land colonization and settlement agencies in all parts of the United States. The nearly complete response of these agencies to requests for information have made it possible to render more efficient service to those seeking information relative to area, location, and type of land for sale, prices asked, terms of purchase, etc.

Official and semiofficial agencies in various parts of the United States which are interested in land-settlement activities either directly or indirectly were visited during the year and State laws and the administration of laws pertaining to land colonization and settlement activities were studied. The purpose of this work is to help public and private agencies lay the groundwork from which settlement expansion may be directed in accordance with sound economic principles.

LAND APPRAISAL AND LAND VALUES

The third annual nation-wide survey of the farm real-estate situation was completed and published as Circular No. 101, The Farm Real-Estate Situation 1928-29, and the fourth annual survey was begun. The third survey showed that, although land values generally continued the downward trend, the declines during the year ended March 1, 1929, were comparatively slight and in a number of States represented the smallest annual loss recorded since the depression set in. Fewer foreclosures and other forced sales occurred, the rate for all types of "distress" transactions having declined from 22.8 to 19.4 out of each 1,000 of all farms. The survey cautioned, however, that there was no assurance that the bottom had been fully reached in all States; that the distress-sale rate was still high; that the demand for farms was still generally very low; and that little relief from the heavy tax burden on real estate was in sight.

That the bottom had not been fully reached in land values in early 1929 is borne out by the preliminary figures for the year ended March 1, 1930. The average acre value for the entire United States on that date stood 15 per cent above pre-war value, as compared with levels 16 per cent above a year earlier, 17 per cent above in 1928 and 70 per cent above in 1920.

By invitation the farm real-estate situation in the Middle West was presented before the land-management short course of the University of Minnesota. This course was the first of its kind expressly established to discuss the problem of foreclosed lands. An analysis of present farm real-estate conditions and the outlook, especially as to values, was regarded necessary as a basis for deciding (1) whether to "dump" acquired properties or hold them for a price, and what price; (2) how much more money it was worth while to spend on them; (3) what sort of management and maintenance policy should be adopted; and (4) whether loaning should be continued, and in what sections and on what basis.

The bureau was represented on the program of the Illinois bankers and land-appraisers short course. The disturbing experiences of recent years have raised an interest never before shown in valuation problems. This was further emphasized by requests from two State experiment stations for a cooperative program of research in farm real-estate values and valuation.

THE PUBLIC DOMAIN

Early in his administration President Hoover brought to the attention of the assembled governors of the western States the need of legislation that would properly regulate the use of the remaining unreserved public lands. Later, with the approval of Congress, he appointed a Public Lands Commission, whose duty is to assemble available information and to make a report and recommendations.

Studies of the factors that affect the use of the public domain have been in progress in the Bureau of Agricultural Economics for several years. A special study of Nevada conditions was nearing completion at the time the commission began work. At the request of the commission, colored maps were furnished to it that picture relationships of legal-tenure range claims, existing and possible use, and control of all the lands of Nevada.

These maps show the distribution and uses of private and public lands, as well as the complicated interdependence of lands having longer or shorter seasonal or otherwise restricted uses. Information is furnished on the complicated and competitive nature of claims now made by stockmen to grazing rights on public lands and the privately owned lands with which these public lands are necessarily associated.

LAND TENURE

A preliminary study of land tenure in its relationship to the declining agriculture of the old plantation Piedmont of the Southeastern States has been completed. Adjustments are being made slowly by many farmers, but much of the land remains unused, and there is no agency charged with the responsibility of determining the best use of the land and with making plans for the future. A comprehensive plan of work for the future should include participation by the State experiment stations and extension services, as well as by a number of bureaus of the Department of Agriculture.

The widespread interest in large-scale farming led the division to undertake an analysis of the census schedules for all farms of 1,000 acres or more in order to indicate where they are, what type of agriculture prevail on such farms, and what are the general economic characteristics of these farms. The analysis is approaching completion and will be available for publication during the coming year.

Summarization of census statistics of farm tenure in the United States has been continued. Cooperative work has been carried on with the experiment stations in Delaware, Maryland, and Virginia.

FARM LABOR

A study on wage payments has been completed which supplements the bureau's periodical reports on average farm wage rates by showing relative and actual amounts of wages paid by farmers to each class of labor during the year and by giving needed data for proper calculation of the bureau's farm wage indices. The data will also be of special value to students of the agricultural labor classes. There are indicated by means of monthly wage payments, the seasons and relative extent of the employment of the principal classes of farm labor, the irregularity of such employment, and the laborer's consequent necessity of supplementing farm work with other paying jobs.

A second study was made with the object of bringing up to date information showing the absolute and proportionate amounts of time spent on farm work by farm operators; by members of their families; by casual, noncasual, and contract-hired laborers; and by croppers. These data supplement the figures of the first study by indicating, from the standpoint of working time and wages, the absolute and relative amounts of employment of each of the principal farm working classes. They indicate not only the working time for hired farm laborers, but also the amounts of work done by members of the farm operators' families.

TOBACCO SECTION

CHARLES E. GAGE, *in Charge*

The tobacco section was organized just prior to the opening of the fiscal year 1930. Two projects were involved, administration of the tobacco stocks and standards act and the inauguration of inspection service for tobacco, commonly known as the tobacco-grading service. In both projects substantial progress has been made.

TOBACCO STOCKS AND STANDARDS

The salient features of the tobacco stocks and standards act are that it requires dealers and manufacturers to report their holdings (1) according to type; (2) according to form, stemmed or unstemmed; (3) according to groups of grades; and (4) according to "new crops" and "old crops." The quarterly reports as formerly made combined certain types and were lacking in the segregation as to grades and time of production. The added detail of the new form had the effect of greatly increasing the burden upon reporters. Necessarily a change of such magnitude had to be approached with caution. By means of hearings held in Washington and attended by representatives of the trade, and by systematic travel and contact with dealers and manufacturers the new form of rendering quarterly stock reports has been successfully inaugurated, and a contribution of important economic value has been made to the statistics on tobacco.

Under the authority of the tobacco stocks and standards act an official classification of types and groups of grades has been promulgated, and systems of grades of certain types heretofore tentatively adopted have been simplified and the way paved for their ultimate promulgation. Plans have been undertaken for establishing a tobacco laboratory for scientific research into the physical properties and characteristics of tobacco.

TOBACCO-GRADING SERVICE

The tobacco-grading service was successfully inaugurated on eight widely-scattered auction markets during the marketing season. The service consists of an inspection of farmers' tobacco on the warehouse floor previous to sale and a certification of grade according to Federal standard grades, accompanied by publication of price reports showing average prices at which each grade is selling on the market concerned. The object is to furnish growers with authentic information as to the quality of their tobacco and enable them to judge for themselves whether the price offered is in line with the market. A further object is to teach growers correct sorting of their tobacco as an aid to better prices. During the first season 11,000,000 pounds of tobacco was officially graded, with benefits to the growers in the form of enhanced prices. The project was well supported by the tobacco trade.

Cooperative agreements for tobacco-grading work were effected with five States, Virginia, North Carolina, South Carolina, Kentucky, and Tennessee.

TOBACCO SORTING AND GRADING COURSE

In cooperation with the State Agricultural College of North Carolina and assisted by officials of that and near-by States, a short course in tobacco sorting and grading was held in Raleigh in April, 1930. The course lasted five days and was largely attended by farmers, agricultural students, representatives of large tobacco manufacturers, and other members of the tobacco trade.

COLD-STORAGE STATISTICS

WILLIAM BROXTON, *in Charge*

Stocks of cream are now being transported over comparatively long distances and are being held in cold storage. Since this commodity has a direct bearing on the butter market, it has been included in the cold-storage report since December 1 of last year.

During the past year a biennial survey of refrigerated-warehouse capacity was undertaken and the results are now available. A complete tabulation will be published, together with data on cold-storage holdings, in a statistical bulletin now in course of preparation. The survey shows that the cold-storage industry has expanded during the last two years by about 9 per cent. In 1927 there were, according to the survey of that year, 1,363 concerns engaged in either public, private, or combined cold-storage warehousing, or meat packing. In 1929 there were 1,400. The expansion in capacity amounted to 60,748,260 cubic feet of warehouse space.

Many requests have been received and complied with, for detailed information on cold-storage stocks. Much of this information is furnished each month. Details of stocks, particularly those of apples and dairy products, eggs, and poultry, are being furnished regularly for a number of the important producing States and a number of distributing cities.

OPERATION OF CENTER MARKET

C. H. WALLEIGH, *Superintendent*

The operation of Center Market, Washington, D. C., has been continued.

Since legislation has been enacted providing for the closing of the market, in order that the site may be used in the building program of the Government, repairs and alterations have been held to the minimum. Supervision of the activities are being continued for the purpose of maintaining sanitary conditions and insuring efficient service to the public, until such time as the plant is discontinued.

ECONOMIC LIBRARY

MARY G. LACY, *in Charge*

The outstanding features of the past year's work of the library were the continued increase in the demand for its services: the steadily widening use of the periodical, *Agricultural Economics Literature*, by economists, educators, graduate students, business and commercial agencies, Federal and State Government officials both in the

United States and foreign countries; and the increase in the requests from various agencies for advice and cooperation in organizing economic literature.

Four new bibliographies were added to the bureau's numbered series, and approximately 40 additional lists were prepared in response to special inquiries.

A total of 4,605 books has been added to the library during the year, and a net increase of 68 periodicals. The files of current agricultural-economics information covering both domestic and foreign work have also been enlarged.

The library has cooperated with the Federal Farm Board, with various State and other libraries, with members of university faculties and others in assisting with the organizing of library work, or in arranging for more complete utilization of the economic material available in the library.

DIVISION OF ECONOMIC INFORMATION

J. CLYDE MARQUIS, *in Charge*

Developments of the past year have served to stimulate greatly the demand for agricultural-economic information of all forms. The widespread growth of interest in economic questions, the problems arising from the price decline of 1929-30, and the advent of the Federal Farm Board have all stimulated interest in economic facts. Farmers, teachers, editors, and others are learning to think in economic terms and are becoming daily better acquainted with the use of such facts. As a result, the facilities of the bureau for the preparation and distribution of such information have been taxed to the utmost.

Every State now has some organized economic work under way that calls for world-wide and nation-wide information. This is a field of education in which local information takes a secondary place. The first need is for a knowledge of world and national markets, prices, production, supplies, etc., because of the fact that local influences are of minor importance. As a result, every new effort in economic education first creates a greater demand for facts from the Federal department.

The calls from general educational institutions, such as public schools, high schools, and business organizations, are growing along with the demand from distinctively agricultural organizations. Our policy has been to serve these groups as well as farmers because agricultural policies are of fundamental importance to all citizens.

Activities of the Federal Farm Board have stimulated the use of our information in some quarters, and the production-adjustment campaigns have laid some very definite burdens upon this bureau. This situation has been met by increased effort without much increase in facilities.

The conduct of the work of the division during the past year has not materially changed in organization but rather has been intensified along particular lines. Decided progress has been made in several lines:

(1) The coordination of publications of the bureau has continued and progress has been made in bringing them to the attention of

agricultural workers everywhere. Several new lists have been prepared for special groups. The head of the division personally visited and addressed extension conferences in seven Northwestern States and two conferences in the South to describe the facilities of the bureau and to outline uses of the material by farmers and extension workers. (2) The radio program of the bureau has steadily grown in scope and volume. (3) Exhibits are in greater demand than ever before, and our facilities for production and handling are inadequate to meet the need. (4) The preparation of special economic articles for newspapers and the farm press has been reorganized and extended. These now reach several million readers weekly.

CURRENT PUBLICATIONS

The need for immediate distribution of many types of information from the bureau makes it necessary to use the multigraph, mimeograph, and other speedy forms of preparation to make the information available. The mimeographing facilities of the bureau were increased during the year by the addition of new equipment and personnel to the bureau unit, and the output of this unit has increased from about 500,000 sheets a month to over 1,000,000 sheets.

New equipment for rotaprinting was purchased in cooperation with other bureaus for the department duplicating section, and this greatly increased the output of charts, maps, tables, etc., for immediate distribution.

In addition to a large number of reports which were issued in mimeographed form, 65 preliminary and special reports were issued during the year in editions ranging from a few thousand to as many as 15,000 copies. Altogether, this method of publication covers a volume of material exceeding the printed publications of the bureau. These preliminary reports have been distributed only to interested research and extension workers and others particularly concerned with the information, and are not available for general distribution.

PRINTED PUBLICATIONS

The two printed periodicals prepared by the bureau, *Crops and Markets* and the *Agricultural Situation*, have been continued through the year with only slight changes. More and more material is being presented for publication in *Crops and Markets*, and an expansion in the size of this periodical has been planned for.

In the regular bulletin series of the department, 44 publications were issued during the year, and, in addition, over one-half this number was in process of editing and publication at the end of the year. A small increase in printing funds available for the bureau was absorbed chiefly in increases in job printing which is constantly growing in volume because of the extension of the service work of the bureau.

The preparation of manuscripts for printed bulletins has been delayed seriously during the year by the heavy demands for emergency work that were made upon the members of the technical staff of the bureau. The total output of the staff in the form of special reports, articles for press, radio, etc., considerably exceeds that of any previous year, but a smaller proportion of this work has found its way into permanent publication.

INFORMATION FOR THE PRESS

Use of press releases as the principal means of announcing the results of bureau work has been continued and expanded in some respects during the year. The number of special releases distributed through the department press service has slightly increased in number, but the principal increase in bureau publicity has been through direct contacts with press representatives.

Two of the principal news syndicates have inaugurated a series of market articles during the year based primarily upon information secured from the bureau. Through these contacts, wide distribution is given to the more important work.

Distribution of bureau information by State publicity agencies has also been improved, since a large number of special local releases are now being prepared by extension editors and others from material furnished by the bureau.

The principal change in the bureau's press relations during the year was an addition to the division staff of a writer and assistant to give their entire attention to the preparation of market reviews for the farm press and leading newspapers. Increased interest in economic information has led many newspapers to accept and publish special reviews. These are prepared for various sections such as the East, South, Middle West and far West, and are sent at the latest possible date to reach the weekly publication in time to go to press. Such articles are now being furnished to 86 publications and reach in this manner a total circulation of nearly 10,000,000 readers. Similar reviews are furnished to several radio stations, and some of them are redistributed by mail to newspapers. One particular review, for instance, is sent to seven radio stations and 46 papers.

RADIO MARKET NEWS

The radio market-news service has been expanded by the opening of contacts through leased-wire offices in Tennessee and Mississippi, and the use of direct messages to a radio station at Raleigh, N. C. The contacts through the New England radio service have been expanded, and effective cooperation is now being had with all of the New England States. The releases of market reports to more than 115 stations has continued through the various branch offices. This service has not been noticeably disturbed by the increase of chain broadcasting.

In chain broadcasting the bureau has continued to contribute a large part of the daily program going from Washington over the national broadcasting chain. Bureau material has also been used in the Middle West chain originating at Chicago. The daily program from Washington is now a recognized feature of national importance, and special programs concerning the outlook, the drouth, and other unusual events, are arranged whenever need arises. This system provides a prompt outlet in emergencies, the value of which can hardly be overestimated.

EXHIBITS

The bureau exhibit section assisted during the year in the preparation of one international show—The World's Poultry Congress at London. An extensive display was arranged for dressed poultry and

eggs, which received favorable comment. The other large expositions of the year were the National Cotton Show, the National Dairy Exposition, International Livestock Exposition, and the Textile Show. Several smaller displays were made for conventions, fairs, etc., which did not come within the scope of the department office of exhibits.

EXTENSION PUBLICATIONS

The outlook-chart service continued to expand, and during the year a total of nearly 5,000 wall charts, 30 by 40 inches, was made for the use of the outlook workers of the various States. A series of outlook-chart books was prepared covering seven subjects, and a total of over 80,000 copies were distributed at outlook meetings. Over 1,000 bureau charts were reproduced for distribution by the rotaprint method, these being used chiefly in extension work. In response to a suggestion of the Federal Farm Board, special extension-chart books on cotton, burley tobacco, and flue-cured tobacco were issued for distribution in the South and in the acreage-adjustment campaign. Over 50,000 copies of these publications were used.

A plan of extending the distribution of economic information to the teachers of vocational agriculture in the high schools was put into operation through contacts with a specialist appointed by the Federal Board of Vocational Education. Copies of bureau publications were distributed to agricultural teachers, and their use by these teachers has increased, resulting in a great increase in distribution to them of information on special economic phases.

MARKET LEGISLATIVE SERVICE

The marketing legislative service, conducted in cooperation with the National Association of Marketing Officials, has been continued through the year with growing usefulness. Aside from the current information issued through the weekly publication, *Marketing Activities*, a survey of the organization and operation of the State departments of agriculture and markets was made.

REPORT OF THE CHIEF OF THE BUREAU OF ANIMAL INDUSTRY

UNITED STATES DEPARTMENT OF AGRICULTURE,
BUREAU OF ANIMAL INDUSTRY,
Washington, D. C., September 8, 1930.

SIR: I present herewith the report of the Bureau of Animal Industry for the fiscal year ended June 30, 1930.

Respectfully,

JOHN R. MOHLER,
Chief of Bureau.

Hon. ARTHUR M. HYDE,
Secretary of Agriculture.

IMPORTANT FEATURES OF THE YEAR'S WORK

The work of the bureau during the year covered by this report dealt, as previously, with a wide range of activities for the protection and betterment of the Nation's livestock industry. It is gratifying to report that no serious foreign livestock disease gained entrance to the United States. Outbreaks of animal maladies within this country also were comparatively limited in extent. Accordingly, the bureau was able to apply its energy fully to research problems, experimental projects, inspection work, and the administration of livestock laws and regulations. The results of the more technical activities, which, for clear understanding, require detailed discussion of methods and data, are published in bulletin form or in the department's Journal of Agricultural Research.

This report, on the other hand, is a general description of activities now in progress or recently completed, together with brief mention of the essential findings to date. It also provides a convenient means for comment on current livestock problems.

ANIMAL-HUSBANDRY RESEARCH

In the field of animal husbandry the bureau has continued to determine the most efficient production methods that are in accord with sound agricultural practice in the various parts of the country and that are compatible with the grade and quality of the finished product desired by consumers. Much of the work during the year was centered about the extensive project on factors which influence the quality and palatability of meat. For several years the bureau has been using superior-type purebred Southdown and Shropshire rams in studying the feasibility of grading up western range ewes

of the type which can be procured at mutton prices on various mid-western and eastern markets. Results in this experiment have pointed consistently to the fact that the first three crosses are more profitable for market-lamb production than are the higher crosses. It is true that the fourth and fifth crosses result in more uniform lambs showing the breed characteristics of the sires, but these lambs have returned less profit per head.

The great vigor which the western ewes bring to the mating is the probable explanation for the better returns obtained from lambs of early crosses. Though pure breeding is essential in the development of improved types of livestock, the importance of vigor and stamina, as shown by this series of experiments, can scarcely be overemphasized in the selection of breeding stock. This conclusion bears especially on breeding operations where commercial fitness is the principal goal.

A further result of investigations dealing with quality in meat shows that lambs produced on good pasture yield meat as satisfactory in finish of carcass and palatability as that of lambs which have received valuable grain feeds. Even lambs which were fed grain in a creep while running on pasture with their dams made a slightly less net return than lambs which had pasture only.

Experiments in producing hogs to make suitable Wiltshire sides for the English bacon market indicate that this can be done satisfactorily with our present American breeds fattened on the feeds commonly grown in this country. The hogs must be rigidly selected for proper type, however, and be fed with the desired market in view. A shipment of hogs fattened at the United States Range Livestock Experiment Station, Miles City, Mont., on barley, tankage, and alfalfa pasture produced Wiltshire sides that sold on the Liverpool and London markets with noteworthy success. The product was declared by British authorities to be equal to the best Canadian bacon.

The hogs were of the Chester White and Yorkshire breeds and crosses of those breeds. The carcasses of these animals also corresponded closely in size and quality to the kind in principal demand on markets of the United States. Thus a farmer can produce for both foreign and domestic markets with the same system of production. Other animal-husbandry investigations have included extensive research in the most profitable method of beef production, using dual-purpose cattle and those of part Brahman origin in addition to animals of the standard beef breeds.

The increasing economic importance of the poultry industry has stimulated research along numerous lines. One cause of serious loss is the failure to hatch of approximately one-third of all the fertile eggs incubated in the United States annually. Inquiry into this condition has revealed that hereditary factors, improper nutrition of breeding stock, and faulty conditions of incubation are chief causes of poor hatches. The year's work has shown further that hatchability is influenced by the degree of inbreeding. Experimental, full brother-and-sister matings had a more detrimental effect on hatchability than less intensive inbreeding. Among the nutritional factors influencing hatchability, the character of the proteins fed to breeding stock has an important influence. Means for improving

hatchability of eggs and otherwise reducing losses and increasing returns in poultry raising are discussed in publications which may be obtained on request.

PREPAREDNESS FOR DROUGHT

The extensive period of drought during the summer of 1930 suggests the desirability of greater attention by livestock owners to feed and water supplies in the future. Suitable preparation should be effective in reducing losses from this cause. In much the same manner that stockmen prepare for long months of winter, there is opportunity to take practical precautions against temporary shortages of feed and water during other periods of the year. The bureau has prepared definite recommendations to this end in a new publication on handling livestock during drought. The preservation of valuable feeding stock during such times should receive special attention in view of the many years normally required to replace such animals.

LIVESTOCK IMPROVEMENT

Continuing the work of former years in encouraging livestock improvement, the bureau cooperated with livestock specialists and county extension agents throughout the country in this activity. Taylor County, Ky., which last year eradicated all scrub and grade bulls, succeeded in freeing itself also from scrub and grade boars. Several counties are now striving, with promise of success, to place all livestock-breeding activities within their borders on a purebred-sire basis entirely. The county unit has proved to be an excellent basis for livestock-improvement work and there has been steady progress under the so-called better-sires campaign. The number of livestock owners participating in this activity for a wider use of purebred sires increased to a total of 17,412 at the end of the year. The bureau's series of publications, posters, and other educational material relating to livestock improvement is now unusually complete and persons who desire such literature for use in their localities may obtain copies on request.

CAMPAIGN AGAINST TUBERCULOSIS MAKES NOTEWORTHY PROGRESS

In the campaign to eradicate tuberculosis from cattle, swine, and poultry another new high total in the volume of tuberculin testing was established during the year. This work was directed principally against tuberculosis of cattle, of which 12,845,871 were tuberculin tested during the year, or an average of more than a million cattle a month. The bureau's biennial survey to determine the approximate extent of bovine tuberculosis in the United States showed the degree of infection on May 1, 1930, to be 1.7 per cent. This is a noteworthy decrease compared with 1.8 per cent, which was the corresponding figure resulting from the survey made two years previously. The decline in the extent of bovine tuberculosis is still more apparent when considered in comparison with the 4 per cent of infection revealed by the first biennial survey in 1922.

The area plan of conducting tuberculosis-eradication work continues to be highly successful. At the close of the fiscal year 1931

counties were recognized as modified accredited areas, signifying their practical freedom from bovine tuberculosis. This figure represents an increase of 236 counties over the corresponding number for the previous year.

A high degree of infection of bovine tuberculosis remains in about 67 counties, but, with the exception of a few in California, these counties are confined to the northeastern part of the United States. The Supreme Court of California has ruled that State indemnity for tuberculous cattle can be paid in that State; therefore, as soon as appropriations are provided rapid progress is expected in the eradication of tuberculosis among cattle in California. All the States in which a high degree of infection remains are prepared to proceed energetically and systematically with the eradication of this disease.

PROGRESS IN TICK ERADICATION

Tick eradication continues to make substantial additions each year to the tick-free territory in the Southern States. During this year Alabama became free from Federal quarantine, being the tenth State of the 15 originally infested to achieve complete release, and on June 11, 1930, the Secretary of Agriculture approved the release, effective July 1, 1930, of all territory remaining in quarantine in Mississippi. The close of the year finds the area in the United States quarantined on account of tick fever in cattle reduced to less than 20 per cent of its original size and confined to parts of four Southern States.

As the fiscal year closes in the midst of the active tick-eradication season only a part of the year's accomplishment can be recorded in this report. The release of territory usually occurs late in the calendar year when, as a result of the season's activities, the exact status of the quarantined area may be determined. In many areas recently freed from ticks a gratifying interest is being shown in the improvement of the native cattle. Many purebred animals, particularly purebred bulls, are being introduced into these sections where fever ticks and scrub sires have held sway in the past.

INFECTIOUS ABORTION

The need that exists for more practical and more uniformly successful methods of combating infectious abortion has prompted the bureau to deal vigorously with this problem.

Methods of transmission, artificial immunization, and the intercommunicability of cattle and swine abortion are matters which have received special consideration since they are phases of the problem on which knowledge is limited.

The discovery that the diseases can be regularly transmitted to susceptible, pregnant cows by depositing minute quantities of the abortion germs on the mucous membrane of the eye has suggested that in infected herds this avenue of invasion for the disease may be a factor of some importance. The success attained in the experimental transmission of the disease by depositing limited quantities of the abortion germs on slightly scarified skin areas, as well as on areas of the skin that are intact, suggests that this portal of entry for the infection may also be one of some importance under natural conditions.

The immunizing effects of different strains of the abortion organism have received more attention than formerly with the view of determining whether it may be possible to select, for vaccine production, strains that will produce a satisfactory immunity and at the same time be free from the danger of becoming established in the udders and eliminated in the milk of treated animals.

Recent discoveries regarding *Bacterium abortus* infection of persons have stressed the importance of further investigative work on this matter if the use of abortion vaccine is to meet with general approval.

STUDIES OF ANIMAL PARASITES

Animal parasites continue to be a problem of major importance to the livestock industry, notwithstanding excellent progress, through research, in developing means for their prevention and eradication. In some regions of the country the parasite factor virtually controls the profitable production of certain species of livestock and poultry. Moreover, where practical control measures are now in operation, the benefits are often so striking that extension workers have included demonstrations of parasite control in their livestock projects.

A noteworthy development of the year was the establishment, at Beltsville, Md., of a small experiment station for studies of animal parasites. The facilities of this station will be used to ascertain in small-scale tests the survival and longevity of parasite eggs and larvae under various conditions of soil, moisture, temperature, sunlight, and other factors. Information of this kind is needed as a sound basis for pasture rotation, fertilization with manure, plowing from the standpoint of parasite control, and related branches of farm and livestock management.

Research during the year resulted in several new discoveries. Studies on anaplasmosis showed that this disease of cattle can be transmitted from an infected to a susceptible animal by pricking the ear of the former and then pricking the ear of a susceptible animal with the same lancet. This knowledge lends weight to previous warnings that veterinary instruments, such as dehorning saws and clippers, should be thoroughly cleaned and sterilized to prevent the possible spread of anaplasmosis. Investigations likewise have shown that the brown dog tick may transmit this disease.

Work on horse parasites indicates that the larvae of the strongyles are extraordinarily resistant to exposure, having remained alive in manure on pasture under Montana conditions for two years.

Control work on liver flukes of cattle and sheep in California gave excellent results and the areas in which fluke eradication was conducted during the previous year showed no trouble from the parasite during the fiscal year just ended.

ENFORCEMENT OF PACKERS AND STOCKYARDS ACT

In the field of regulatory work, a decision of the United States Supreme Court, on February 24, 1930, settled definitely the authority of the Secretary of Agriculture to prescribe charges for services of commission men at stockyards posted under the packers and stockyards act. In this case the Secretary, by an order dated November 19, 1926, had lowered the maximum commission charges for handling

livestock at the Omaha stockyards. Fifty-nine concerns affected by the order, all of which were registered under the packers and stockyards act as market agencies, joined in challenging the validity of the order in the Federal courts, raising two major questions, (1) the constitutional authority of the Secretary to fix commission rates and (2) the alleged confiscatory character of the rates which he had prescribed. The Supreme Court upheld the right of the Secretary to prescribe rates for buying and selling livestock at public stockyards and also decided that the rates which he had prescribed were reasonable and not confiscatory.

Another forward step in connection with the enforcement of this act was the trade-practice conference for the meat-packing and wholesale meat industry held at Chicago, Ill., on October 22, 1929, at the invitation of the Secretary. This conference resulted in the unanimous adoption of a code of trade practices of the American meat-packing industry. This code, having for its purpose the elimination of unfair and uneconomical practices among packers and wholesale meat dealers, received the approval of the Secretary in a statement issued to the public November 11, 1929. Subscribers to the code have taken effective measures to obtain compliance with its provisions by establishing an adequate system of handling complaints for minor violations which, although contrary to the provisions of the code, would not be violations of the packers and stockyards act. The adoption of this code and compliance with its provisions should have the effect of building up a high standard of ethics in the business.

PERSONNEL

The bureau rolls at the beginning of the fiscal year showed 4,252 employees of all grades and designations in Washington and in the field. During the fiscal year 507 were added to the rolls, 459 by appointment or reappointment, 25 by transfer from other bureaus or departments, and 23 by reinstatement. During the same period 114 employees resigned, 24 died, 17 were transferred to other bureaus or departments, 46 were retired under the amended retirement act of July 3, 1926, and 4 were removed for cause. Other separations, principally of agents, unskilled laborers, and seasonal temporary employees numbered 247, making the total separations for the fiscal year 452. On June 30, 1930, the bureau rolls carried 4,307 employees.

VETERINARY EDUCATION

The operation of the accredited veterinary colleges during the school year 1929-30 maintained the tendency toward increased enrollment shown during the preceding year. The number of graduates of the school year was 167 as compared with 141 the previous year, an increase of 26. While the registration of freshmen increased only 17 from 330, the number for the previous year, the attendance of all classes increased from 896, the total for 1928-29, to 1,055 for 1929-30.

The number of accredited veterinary colleges remains at 12, each being under the supervision of the State in which located. The number of foreign recognized veterinary institutions is 10, as in the previous year.

PUBLICATIONS, RADIO, EXHIBITS, AND MOTION PICTURES

Publications prepared by the bureau during the year included 157 new and revised documents, an increase of 11 over the previous year. Contributions to the various series of publications included 84 farmers' bulletins, 6 technical bulletins, 2 leaflets, 10 contributions to the Journal of Agricultural Research, 8 orders of regulatory character, 23 Yearbook articles, 11 publications of miscellaneous nature, and 13 Service and Regulatory Announcements, including the index.

The bureau furnished to the press service of the department numerous timely articles dealing with topics of public interest. In addition, employees of the bureau contributed 98 manuscripts on various phases of livestock work and research to technical and agricultural periodicals.

In cooperation with the department's office of exhibits bureau specialists furnished subject-matter material for 9 new exhibits and the revision of 29 former ones for use at State fairs, expositions, and similar events. In addition, the bureau prepared 2 new exhibits and revised 2 others besides furnishing maps, charts, and pictorial material for exhibition at numerous meetings.

As in former years, the bureau cooperated with the department's office of motion pictures in the preparation of scenarios and in making or revising such pictures from a subject-matter standpoint. Prominent in this phase of the year's work was the preparation of several new motion pictures on the poultry industry for use at the World's Poultry Congress in London, England, July 22-30, 1930.

The work of the various divisions of the bureau during the past year is presented more fully in the following pages.

ANIMAL HUSBANDRY DIVISION

The work of the Animal Husbandry Division, consisting chiefly of research in animal husbandry, including poultry husbandry, was conducted under the direction of E. W. Sheets, chief.

ANIMAL GENETICS

Accumulated data in the bureau's inbreeding investigations with guinea pigs show that significant differences among families in rate of gain, earliness of maturity, and mature weight have been brought out and maintained by inbreeding. In the inbred family which produced the lightest pigs the average mature weight was 779 grams; in the family producing the heaviest pigs it was 965 grams. The mean mature weight in the control stock was 1,028 grams. In crosses between inbred families a remarkable increase in weight was shown, but the average increase was not great enough to make the crossbreds heavier than the control stock. The inbred families, however, were only about 58 per cent as variable in rate at 1 year of age as the noninbred control stock.

An extensive statistical study has been made of various factors which affect growth and of the interrelations between rates of growth for various periods in the life of the guinea pig. The results show that it has been possible by inbreeding to modify greatly

such characteristics as rapidity of growth at different stages, but that this effect is independent of other characteristics such as size and frequency of litters and ability to raise young. Only by inbreeding can differences in characteristics be brought to light and maintained. The practical breeding problem, then, becomes one of making combinations of the desirable characteristics by intelligent mating accompanied by rigid selection.

Swine-inbreeding investigations have progressed to the point where one inbred line is rather firmly established in the Chester-White and Tamworth breeds. The Poland-China stock used exhausted itself by low fertility and high mortality of the young after two generations of inbreeding. This result, undoubtedly, was due to invisible weaknesses in the foundation animals.

A small X-ray laboratory has been equipped for use in various phases of animal-husbandry investigations. Studies were made of the effects of the X rays on genetic characters in guinea pigs and on the sex ratio in poultry. Limited use has also been made of the apparatus for photography in connection with bone development. A very promising use which preliminary work has indicated is in connection with a determination of vertebrae numbers in young swine, thus making possible the selection of breeding stock on the basis of numbers of ribs, a characteristic affecting the length of the side of bacon and the loin—two of the high-priced cuts of pork.

ANIMAL NUTRITION

Studies of the effect of rations deficient in calcium and phosphorus on the development of the skeleton and teeth of swine have been continued in cooperation with Johns Hopkins University and the American Dental Association. Definite malformations of the teeth and jaws have been found in pigs from lots fed diets (1) high in calcium and low in phosphorus and (2) high in phosphorus and low in calcium. Deficiencies in the diets of the sows during pregnancy have more serious effects than those existing in the feed of the pigs after weaning, with an intermediate effect resulting from similar deficiencies during the suckling period.

Very slight differences were found in the composition of the whole kernels of corn from cornstalks lightly and heavily infested with the corn borer.

The study of the best nutritive conditions for the growth and fattening of poultry is being continued in cooperation with Johns Hopkins University. A type of leg weakness developed on certain diets that did not appear to be related to a vitamin deficiency.

A comparison of the value of shrimp bran with fish meal as a source of protein for growing chicks showed the fish meal to be superior.

The breast muscle of squabs when compared with that of the mature pigeon was found to contain slightly more soluble protein, although the nature of the soluble protein does not seem to be essentially different.

The nature of fat formed by swine on a high-protein, moderate-carbohydrate ration was found to be essentially the same as that formed on a low-protein, high-carbohydrate ration. Swine fed a ration nearly devoid of fat (brewers' rice, alfalfa meal, and blood

meal) synthesized and stored fat at a normal rate. A hard, saturated fat was formed, the principal fatty acids of which were oleic, palmitic, and stearic.

COOPERATIVE EXTENSION

As in the past, the Animal Husbandry Division has cooperated, through its two extension representatives, with Federal and State extension workers in the establishment and continuance of projects aiming toward livestock betterment.

Beef-cattle activities in the farm States centered around beef-herd demonstrations and steer feeding, while in the range States culling of the breeding herd, supplemental feeding, range improvement, and disease control were featured. In the case of swine, the use of protein supplements and pastures, and management practices—such as selection and culling, the control of parasites and the saving of young pigs—were the basis of most of the work. Sheep work in the farm States consisted largely in farm-flock demonstrations in which the practice of using good purebred rams, docking and castrating lambs, treating for parasites, and proper feeding predominated. Range-sheep work involved culling of the breeding flock, proper range management, lamb feeding, and marketing. Horses and mules occupied a relatively small part of the time of workers, although several States conducted numerous demonstrations in the use of multiple hitches and promoted colt, stallion, and gelding clubs.

General production projects, such as the ton-litter clubs, swine sanitation, pig-crop and pork-production contests, and car-lot baby-beef and lamb-production contests, made marked growth during the year, particularly in the Central States. Grading and marketing, as they influence production, were given increased attention throughout the country. More satisfactory methods of cooperation with commercial and semicommercial agencies have been worked out in many States.

In poultry extension work emphasis has been given the system of flock management whereby pullets come into production in the early fall months. Farmers who followed this system during the year obtained very satisfactory financial results. As in the past, another major activity was culling work to eliminate the low-producing hen, with the gratifying exception that this feature is now being carried on by farmers themselves and by flock-improvement associations, which have been organized in a large number of the important poultry-producing States.

MEAT INVESTIGATIONS

Meat investigations have been continued in cooperation with the Bureaus of Agricultural Economics and Home Economics and 25 State experiment stations. This work has resulted in the development of methods of research as well as standards by which quality in meats may be recognized and measured.

For example, the physical and chemical analyses of large numbers of standard samples from beef carcasses of known history are providing a basis for determining the relationship between the appearance of the animals and carcasses, as determined by expe-

rienced judges, and the nutritive value, probable shrinkage during cooking, and tenderness of the various cuts. Such information should be of interest and help to the housewife and invaluable for dieticians and chefs.

During the year a number of State and Federal stations compared the beef from steers and heifers. Results of several experiments, including cooperative work with the Arkansas, Colorado, Michigan, Missouri, Mississippi, and Ohio stations, showed that well-bred heifer calves of beef type reached a desirable market finish as light yearlings more quickly and at lighter weight than similar steer calves. It follows that the heifers passed the point of desirable finish at a lighter weight than the steers. These light, open heifers showed a dressing percentage fully as high as the steers, and the heifer beef was fully the equal of the steer beef in palatability, when the two were slaughtered at the same time.

Results of cattle-grading work conducted in cooperation with the Bureau of Agricultural Economics and a large number of the State agricultural experiment stations, involving more than 2,000 cattle, showed that width and depth of body, shape of head, and refinement are reliable indications of the grade of the animal as a feeder. However, feeder-cattle grade has not shown a high correlation with rate of gain during the feeding period. In this grading of feeder cattle the factors which indicate the conformation, finish, and quality of the carcass at the end of the feeding period were the primary considerations.

Other studies have dealt with the differences in meat from animals of various degrees of beef breeding, including dairy stock and cattle of part Brahman ancestry. The beef of mature steers fed on grass alone compared rather favorably in finish, tenderness, and palatability with that of similar steers receiving grass and a supplement of grain. The comparison is being repeated with younger cattle in an effort to learn at what ages beef cattle can use a maximum of grass to best advantage in producing beef of reasonably good quality.

In studies of quality in pork, fat content as determined by chemical analyses is being compared, for large numbers of animals, with cutting yields, carcass measurements, and total weights of the carcasses to develop a method by which the approximate nutritive value of the meat may be determined without recourse to the laboratory.

Data from approximately 600 hogs, part of which were used in cooperative experiments with the Michigan, Mississippi, North Carolina, and Ohio stations, show that cutting yields of carcasses are a reliable index of degree of fatness. The data also indicate that barrows tend to be fatter than gilts of similar weight.

Lamb studies have included the sampling and testing of large numbers of cooked and uncooked legs of lamb, involving chiefly comparisons of breed, degree of fatness, and aging of the carcass, as these factors affect palatability and tenderness. The meat of suckling lambs produced on good pasture was as satisfactory from the standpoint of both finish and palatability as that from suckling lambs which received a supplement of grain on pasture.

During the year carcasses or cuts of 883 hogs, 957 lambs, and 55 cattle, as well as 115 pairs of beef ribs, were studied at the division's meat laboratories.

BEEF AND DUAL-PURPOSE CATTLE INVESTIGATIONS

Research in beef production has been conducted in the Appalachian region, the Corn Belt, the coastal plain, the Sugarcane Belt, and the western range areas.

BEEF-CATTLE RESEARCH IN EASTERN UNITED STATES

The first year's work of a new experiment to compare grass alone and grass supplemented with corn and cottonseed meal for fattening 2-year-old steers was completed at Lewisburg, W. Va., in cooperation with the West Virginia Agricultural Experiment Station. Five lots of steers were used.

A lot on grass alone for 126 days lacked much in finish and sold for slaughter at a loss of \$10 a head. Another lot on grass for the same time, with a ration of 9.6 pounds of corn and 1 pound of cottonseed meal for the last 70 days, was considerably better finished and made a profit of practically \$2 a head. Another lot, fed a ration of 7.1 pounds of corn and 1 pound of cottonseed meal for 126 days on grass, made only 5 per cent more gain than the steers fed grain for 70 days and sold at a loss of \$2.50 a head. Two other lots, on grass alone for 126 days, were fed 56 days longer with grain in self-feeders. One lot was kept on grass while the other was kept in a dry lot and fed hay. The dry-lot steers made about 5 per cent more gain than those on pasture. The rations of corn were practically the same, 15.2 and 15 pounds, respectively. The dry-lot steers consumed nearly 9 pounds of clover hay per head daily. In the end the loss per head was practically the same, \$5.68 and \$5.88, respectively. Briefly, the results show that 70 days' supplemental feeding of steers on grass with corn and cottonseed meal gave the best returns.

At the United States Animal Husbandry Experiment Farm, Beltsville, Md., a grazing experiment was undertaken, in cooperation with the Bureau of Plant Industry, to determine the rate of stocking and the system of management that will produce maximum gains per acre on improved pasture of mixed seeding. The first year's results indicate that even under the unfavorable weather conditions which prevailed, there being no effective rainfall from June 29 to October 1, 2 acres of pasture of mixed seeding provide adequate continuous grazing for a 2-year-old steer, whereas 1 acre is not enough. At this same station a project is under way to increase through selection and breeding the efficiency of feed utilization by beef cattle in the production of high-grade beef.

BEEF-CATTLE RESEARCH IN THE CORN BELT

The second year of a cooperative project with the University of Missouri was completed at Sni-a-Bar Farms, Grain Valley, Mo., to compare corn alone, corn and cottonseed meal, and corn and oats as grain rations for fattening calves before weaning. Each year three lots of calves were fed these supplemental feeds, respectively, for 140 days. The calves were fed in creeps while on pasture with their dams and were weaned at about 8 months of age. An average of the two years' data shows that the corn and corn-and-oats lots

made practically the same gains, while the corn-and-cottonseed-cake lot made about 10 per cent more gain. In economy of gain there was practically no difference between the corn and the corn-and-cottonseed-cake-fed calves, while the gains on corn and oats fed together were about 10 per cent more costly. To date the indications are that the cheapest and most readily available ration of the three will give the most satisfactory results.

BEEF-CATTLE RESEARCH IN THE SOUTH

At the Coastal Plain Experiment Station, McNeill, Miss., the seventh year of the project in cooperation with the Forest Service comparing burned with unburned cut-over pastures in their relation to beef production and reforestation of pines has been completed. Steers have made 34 per cent greater gains during the grazing season on the burned pasture. Each year except the last the burned pasture produced greater gains than the unburned pasture. In time, however, erosion, loss of humus, and the damage to the trees and seedlings may offset the value of the greater gain made by the cattle.

A significant finding at this station is that grazing diminishes the rough or dead grass and reduces the loss of seedlings by fire. In the case of ungrazed "rough," less than one-fourth of the seedlings survived, while on a grazed inclosure, one-half of the seedlings survived a fire.

On areas which are not burned the survival of seedling longleaf pines is considerably greater than on burned areas for all types of ground cover except carpet grass. Carpet grass is grazed so closely that it can not be burned off. In fact, on closely grazed areas the survival of seedlings is practically the same whether burning was practiced or not, while on lightly grazed areas the rate of survival was 96.6 per cent without burning, and only 10.8 per cent with burning. In areas where little bluestem (*Andropogon scoparius*) predominated, the survival of seedlings was almost 100 per cent and appreciably higher than for other kinds of grasses. When such areas are burned, however, the rate of survival is lowest of all. On ungrazed inclosures which were not burned, 81 per cent of the seedlings survived as against 78 per cent on grazed inclosures. This indicates that reforestation may be carried out while an annual return from the land is obtained through grazing.

At the Iberia Livestock Experiment Farm, Jeanerette, La., the third experiment has been completed comparing steer calves of one-fourth Brahman breeding and three-fourths Hereford breeding with similar calves of half-Hereford and half-Brahman breeding. The half-Brahman excelled the quarter-Brahman calves in two out of three experiments in rate of gain and economy of gain, while the selling price was nearly the same. In dressing percentage the quarter-Brahman excelled the half-Brahman calves in two of the three experiments.

BEEF-CATTLE RESEARCH IN WESTERN RANGE AREAS

At the Range Livestock Experiment Station, Miles City, Mont., a ration of 20 pounds of first-quality bluejoint hay was found to be equal to about 23 pounds of second-quality alfalfa hay for wintering

2-year-old heifers. The heifers fed bluejoint hay made slightly better winter gains and practically the same summer gains as heifers fed the same quantity of alfalfa hay. These results are the average of three experiments in which a total of 118 heifers were involved.

Two-year-old steers wintered on a ration of 23 pounds of alfalfa hay made about 10 per cent more gain for the winter and following summer grazing season than similar steers wintered on a similar ration in which oat straw was substituted for one-half of the alfalfa. Therefore, the alfalfa-and-straw wintering ration is preferable whenever it is enough cheaper to more than offset the value of an additional 30 pounds of weight on the 2-year-old steers the following fall.

As a result of three experiments involving 200 calves, about 13 pounds of alfalfa proved to be a better ration for wintering than the same quantity of hay supplemented by three-fourths of a pound of cottonseed cake, and also than about 10 pounds of alfalfa and 9 pounds of corn silage. While the more expensive rations, resulting from supplementing alfalfa hay with cottonseed cake or corn silage, produced considerably greater winter gains, they were followed by slightly smaller summer gains on the range. There was not difference enough in the gains for the winter and summer periods combined to justify the addition of cottonseed cake or corn silage to the alfalfa ration.

In two consecutive experiments in cooperation with the Bureau of Plant Industry in wintering yearling steers at the Ardmore field station, Ardmore, S. Dak., 16 pounds of corn silage proved to be practically equal in feeding value to 8 pounds of alfalfa hay when each was supplemented with 4 pounds of oat straw. One experiment indicated that 14 pounds of sorgo stover is better than either the alfalfa-hay or corn-silage ration.

In a grazing experiment with steers which has been carried on for 12 successive summers, a lightly grazed pasture produced on the average 15 pounds' gain per acre annually; a heavily and continuously grazed pasture produced 19 pounds; and a pasture divided in half and grazed equally heavily in rotation produced 20 pounds of gain per acre annually. In this rotation-grazed pasture the gains per steer as well as the gains per acre were the largest.

At the North Montana branch station, Havre, Mont., in cooperation with the Montana Agricultural Experiment Station, an attempt has been made for several years to produce baby beef, but considerable trouble has been experienced with so-called barley bloat. Calves fattened on barley and alfalfa begin to bloat when they receive up to 5 pounds of barley a head daily and continue to bloat until they are on full feed when the trouble ceases, except for an occasional bloat or the continued bloating of the calves that became chronic bloaters. In one trial, cutting the hay with a silage cutter and mixing the grain with the cut hay seemed to reduce the amount of bloat and made it easier to keep the calves on feed.

During the year a method of feeding was used which gives more promise of being successful than any other method or ration tried. One lot of calves was fed 3 pounds of grain per head daily all winter; the grain was increased and the calves were placed in a native pasture and full-fed grain until September, at which time they were full-fed grain and alfalfa in dry lot for two months. No trouble from bloat was experienced in this lot. These calves were

the fattest cattle ever produced at this station and returned a very good profit.

Rye has proved to be inferior to barley as a fattening feed, because the calves would not consume enough of it to get fat.

In western range investigations technical bulletins are being prepared for publication giving the results of intensive studies of ranch management in the Edwards Plateau and north central Texas. The first year's work of a similar study on 37 ranches in Colorado and Wyoming has been completed. Particular attention is being paid to the labor requirements and cost of putting up hay. In connection with this work a survey was made of all feeder cattle to be marketed from these areas for incorporation with similar data from other parts of those States for distribution to buyers of feeder cattle.

DUAL-PURPOSE CATTLE INVESTIGATIONS

The project to determine the mode of inheritance of milking and beef characteristics in dual-purpose cattle was advanced during the year by obtaining additional foundation stock from different parts of the United States, Canada, and England. Owing to lack of facilities the investigations during the year were confined to records of feeds used, gains in weight, pounds of milk produced, and photographs showing the degree and rate of fleshing.

In addition, three cooperative projects under this major project have been worked out with the Purdue and Minnesota Agricultural Experiment Stations, which will provide herds for study. The division desires to have the cooperation of as many animal husbandmen as possible in the States where herds of purebred, dual-purpose cattle have been established and where grade beef cattle are milked extensively.

SHEEP, GOAT, AND ANIMAL-FIBER INVESTIGATIONS

The bureau's program of research in problems relating to the sheep, goat, and animal-fiber industries has included experimental work at 15 Federal and State experiment stations, 2 commercial woolen mills, and 1 hospital clinic for testing the food value of goat's milk for infant feeding.

FARM-SHEEP INVESTIGATIONS

Forage-crop studies in sheep-carrying capacity of pastures at Beltsville show, in Table 1, the yield of various kinds of pasture in terms of grazing per ewe per day.

TABLE 1.—*Sheep-carrying capacity per acre of temporary pastures at United States Animal Husbandry Farm, Beltsville, Md., for calendar years stated*

Crop	Ewe - days grazing per acre		Crop	Ewe - days grazing per acre	
	1920-1928 (average)	1929		1920-1928 (average)	1929
Soybeans.....	352.6	351.1	Wheat.....	274.6	194.3
Corn and velvet beans.....	348.8	236.1	Barley.....	265.3	263.2
Oats and peas.....	348.0	329.6	Rye.....	163.1	353.4

The rather low yield of three of the crops in 1929 was due to the excessive rainfall in the early spring followed by a period of continued drought during the months of June, July, and August. The early spring pastures, as a rule, did better than those affected by the drought, although winter wheat was frozen out badly, thus reducing the quantity of feed produced. Fall-sown rye showed the best results obtained with this crop during the 10-year period.

Experiments to determine the value of flushing, the practice of giving ewes extra feed at breeding time to increase the lamb crop, were continued. At Beltsville, a decided benefit was derived from providing good pasture at that time. The lambs produced by ewes receiving good pasture numbered 160 per 100 ewes while another lot of ewes flushed with grain produced 141 lambs per 100 ewes. The check lot held on scant pasture, or in an unflushed condition, produced only 116 lambs per 100 ewes.

This test substantiates previous data indicating that good pasture is the best feed for flushing ewes, but that satisfactory results may be obtained by feeding grain when such pasture is not available.

Reports from the Belle Fourche field station, Newell, S. Dak., show a lambing percentage, on a basis of ewes lambing, of slightly over 200 for the season. This exceptional lambing result is possibly due to the excellent feed and climate of the section for sheep production. This explanation is supported by the fact that the entire flock, consisting of 132 purebred and high-grade Hampshires, produced an average fleece weight of 9.19 pounds, or about a pound above the average of other sheep in that section.

To check the feeding value of shrimp bran, as compared with linseed meal, for wool production, the ewe lambs at Beltsville were divided into two lots of 22 lambs each. To a ration of 8 parts of oats, 8 of bran, and 4 of corn, by weight, 2 parts, by weight, of linseed meal were added for one lot and 2 of shrimp bran for the other. At the end of 11 weeks' feeding the gain in body weight for the two lots was identical, while the unscoured fleece weight of the shrimp-bran lot averaged 2.2 per cent less in weight.

At Middlebury, Vt., the grading-up experiment again showed third-cross Southdown and Shropshire lambs to be more profitable by a margin of 45 cents a head than those of higher grades, although not so typical, from a standpoint of breed characteristics, as fourth and fifth crosses. The western ewe foundation of these crosses was of the Lincoln-Rambouillet crossbred type.

The results of the ram-*v.*-wether lamb experiment at the Middlebury farm showed that, owing to greater weight, the ram lambs, as appraised at the Jersey City market, were worth 24 cents more a head than the wether lambs. The rams averaged 7 pounds more before slaughter, but their chilled carcasses averaged only half a pound more than the wethers. This was due to the higher dressing percentage of the wether lambs. The average grade of the wether lambs, both live and dressed, was higher than that of the ram lambs. Cooking tests showed the wether lambs to be more tender and slightly more desirable.

These data are in substantial agreement with similar previous tests conducted by the bureau.

RANGE-SHEEP INVESTIGATIONS

Studies conducted at the United States Sheep Experiment Station, Dubois, Idaho, on range utilization and management, included observations of the effect of climatic condition on the growth and development of range forage and the combined effect of these factors on range-sheep production.

The important effect that weather conditions have on range-sheep production was demonstrated in a striking manner. The weather during the year ended June 30, 1930, was favorable for the development and growth of range forage at the station and experimental sheep were maintained in satisfactory condition. As a result losses of breeding sheep were small and comparatively large crops of lambs and wool were produced. It appears that the lamb crop is more seriously affected by adverse weather and range conditions than is the unscoured weight of the wool crop. A comparison of lamb and wool production for the last year and the one previous, which was very unfavorable, shows that the percentage of lambs living at shearing time was 73 in 1929 and 97 in 1930, while the average fleece weight per sheep varied only from 11.4 pounds in 1929 to 12 pounds in 1930. Likewise, losses of breeding sheep were greatly influenced by climatic conditions, being about 5 per cent in a favorable year and 10 per cent in an unfavorable year.

Large areas of western lands have in recent years been broken up for dry-land farming. The attempt to produce dry-land crops was largely unsuccessful on lands typical of the area surrounding Dubois, Idaho; in consequence the land has been abandoned and is reseeding to Russian thistles by natural means.

There has been some indication that the Russian thistles can be grazed with fair success by sheep in some winter seasons. A preliminary trial was conducted during January and February to determine whether it is practicable to attempt to use Russian thistles for winter grazing by sheep. A band of ewe lambs receiving one-half pound of oats per head daily as a supplement was grazed on Russian thistles for 25 days in January. Also, a band of breeding ewes was grazed on Russian thistles for 20 days in January and February and received one-third pound of whole corn as a supplement. Both bands were maintained in gaining condition and no harmful effects were observed. The sheep prefer thistles, which because of a heavy stand are short and immature. These thistles turn black when frosted but they are highly palatable and are readily taken by sheep at any time during the fall or winter. Sheep appear to do best on Russian-thistle pasture when it is covered with a light blanket of snow.

Sweetclover chaff was fed to a band of ewe lambs as a part of their winter ration. This chaff is a by-product of the sweetclover-seed industry, which is of growing importance in Idaho and other Western States. The chaff consists of broken stalks and stems of varying lengths, some crushed leaves, and seed hulls. The sweetclover chaff used in this test was dry and reasonably green and was fed to the lambs in a ration consisting of 2 pounds of chaff and 2½ pounds of alfalfa a head daily. The lambs ate all the chaff except the pieces of coarse, woody stems. The use of this chaff as a part of the wintering ration for ewe lambs reduced the cost of the winter

ration by 20 per cent and also demonstrated that it can be well utilized in this manner.

Six Southdown yearling rams were tested to determine whether this breed is adaptable to western range conditions and suitable for range breeding operations. Results obtained from one breeding season indicate that Southdown rams can be maintained in satisfactory breeding condition when herded with a band of range ewes. Lambs sired by these rams appeared to be more vigorous at birth than either purebred Corriedales or Rambouillets. However, when the Southdown rams were placed in bands of range ewes with Corriedale rams or Rambouillet rams, they settled only from 20 to 30 per cent of their allotted number of ewes.

The United States Range Livestock Experiment Station at Miles City, Mont., experienced in the spring of 1930 one of its best lambing seasons. The ewes began lambing April 1 and by the end of the month 1,133 lambs had been produced by 955 ewes, or 118.6 per cent of living lambs, a remarkable record for Rambouillet ewes under range conditions.

KARAKUL-SHEEP INVESTIGATIONS

Investigations in the production of skins valuable for fur were continued by the crossing of Corriedale and Blackfaced Highland ewes with Karakul rams and comparing the skins of the resulting lambs with those produced by the lambs of the purebred Karakul ewe flock at Beltsville. The skins were compared for both tightness of curl and luster of the fur. Those produced by the first-cross Karakul-Highland lambs were found to be superior to the Karakul-Corriedale skins in both tightness and luster, averaging 89 per cent as good as the purebred Karakuls in tightness of curl and 85 per cent as good in luster of fur. The first-cross Karakul-Corriedale skins averaged 71 per cent as good as the purebred Karakuls in tightness of curl and only 54 per cent as good in luster of fur.

Both of these crossbreeds show considerable promise as a basis from which sheep may be graded up to a high percentage of Karakul blood, the ultimate top crosses of which will be valuable for the production of marketable lambskins for use as fur.

ANGORA-GOAT INVESTIGATIONS

Studies with Angora goats were continued, in cooperation with the Texas Agricultural Experiment Station, at Sonora, and at College Station, Tex. Breeding studies have indicated the possibility of eliminating kemp from the fleeces and a continuation of the work now in progress promises early solution of the problems of the best method of accomplishing that result.

MILK-GOAT INVESTIGATIONS

Studies were made of feeding hay of different qualities to goats to determine the effect on milk production.

During March good-quality alfalfa hay was fed liberally to 10 does in combination with a mixed-grain ration, varying from $1\frac{1}{4}$ to $1\frac{3}{4}$ pounds a head daily, resulting in a total production of 1,727 pounds

of milk. The next month these same does were fed an equal allowance of grain and the same quantity of rather poor, coarse clover. The milk production for the month dropped to 1,439 pounds, or a decrease of 16.6 per cent, which is significant in view of the fact that in previous years, when the does were held on the same type of feed throughout the two months, the milk production in April was uniformly higher than in March.

Further proof of the need of good roughage for the highest milk production is furnished by feeding data for February, March, and April in 1929 and 1930. Ten does averaged 157.7 pounds of milk a month in 1930 as against 119.7 pounds a month for the same does during the same period in 1929. The only difference in the feed provided was the quality of the hay. The quantity and quality of the grain, as well as of hay feed, were the same both years.

STUDIES OF WOOL

Results of experiments on wool fineness as influenced by rate of growth were published in the *Journal of Agricultural Research*. The indications from this study are that character of fleece is largely within the control of the flock owner because of the close relationship between the thriftiness of the sheep and the quality and quantity of wool it produces. This observation has been borne out in the case of two Shropshire rams. These animals, each weighing about 200 pounds, gradually lost about 30 pounds in weight and at the same time showed a reduction of 30 per cent from normal, lineal, wool growth in a period of 28 days. The results from supplemental feeding of sheep on the range show that a group of sheep receiving the more liberal feeding grew from 9 to 14 per cent more length of wool during the periods of least growth for three consecutive years.

Data obtained from the Rambouillet, Corriedale, and Columbia breeds of sheep in the study of the factors that influence production, growth, and quality of wool, which was carried on in 1921 to 1924 inclusive, have now been analyzed. They show that the Corriedale breed averaged 3.9 pounds of clean wool per fleece as compared with 4 pounds for the Rambouillets and 4.5 pounds for the Columbias. The average annual lengths of staple wool for these breeds were 3.5 inches for the Corriedales, 2.2 inches for the Rambouillets, and 3.3 inches for the Columbias. Fineness of fleeces in Bradford spinning counts for the Corriedales and Columbias averaged about 50s, although the fleeces of the Corriedales were slightly finer than those of the Columbias. The Rambouillet fleeces graded slightly finer than 60s. The sheared body weights, as yearling ewes, averaged 78 pounds for the Corriedales, 86 pounds for the Rambouillets, and 91 pounds for the Columbias.

GOAT-MILK INVESTIGATIONS

Goat-milk investigations conducted during the year consisted in comparisons of goats' milk with the milk of Holstein and Jersey cows. In all cases the milk was produced under controlled conditions, during summer and winter feeding periods, and was fed to

infants under the direction of Johns Hopkins University, Baltimore, Md. The milk was boiled for one minute and supplemented with orange juice and cod-liver oil. The relative gain in weight, appearance, and well-being of the infants on each of the three milks were studied. When the different milks were fed under these conditions no essential differences were observed, good results being obtained with each milk.

SWINE INVESTIGATIONS

Investigations carried on in cooperation with 10 State stations in various phases of swine production were continued during the year at Beltsville, Md., and at several field stations.

PORK STUDIES

The influence of soybean rations on the different characteristics of pork was given particular study during the year.

Several stations worked on the problem of increasing the rate of gain of hogs finished on a basal ration of 6 parts corn and 1 part soybeans supplemented with minerals. Previous work had shown that hogs gaining at the higher rates on this ration tended to produce firmer carcasses than those gaining more slowly. Variation in soybean varieties and in mineral supplements, and the addition of 2 per cent of protein from such sources as tankage, fish meal, cottonseed meal, and buttermilk to the basal ration were tried. Indications are that a supplement for this basal ration can be found which will increase the gains sufficiently to produce firm pork.

Several experiments compared soybeans and corn as the basal feed in fattening rations. The principal object was to study the effects on the palatability of cooked meat. Similar experiments were conducted to compare peanuts, brewers' rice, and cull navy beans with corn as basal feeds, tankage with fishmeal and with soybeans as supplemental feeds to corn, and a peanut ration with peanuts followed by a hardening ration of corn. The results thus far indicate that differences in certain elements of palatability may be caused by different feeds.

During the year work was begun in connection with the national swine record-of-performance project, which is a new enterprise. This project involves three major considerations: (1) Breeding performance of the sow, (2) feeding performance of representative pigs from the litter, and (3) carcass qualities of representatives from the litter. Litters from the Federal stations at Jeanerette, La., Miles City, Mont., and Beltsville, Md., were fed and slaughtered. The results give promise of providing an effective and practicable means of discovering and improving even further the most efficient strains of hogs.

Considerable attention was devoted to the development of methods for grading with respect to market grade and type. During the year 764 hogs were graded for both market grade and type immediately preceding slaughter. Steps are now being taken toward the grading, as feeders, of all pigs used in the pork experiments, and, likewise, toward the grading of all corresponding carcasses. It is believed that the feeder, slaughter, and carcass gradings are essen-

tial observations in pork experiments, and that they may prove to have significant relations to other important characteristics of the animal and its dressed carcass. Moreover, the relation of type in the animal to characteristics of its carcass is regarded as important.

BARLEY INVESTIGATIONS

Studies of the effects of "scabbed" barley when fed to livestock are being made with cattle, poultry, and laboratory animals. With hogs it has been demonstrated to be very unpalatable, and, if consumed by them even in very small amounts, scabbed barley causes nausea and vomiting.

Numerous efforts have been made, in cooperation with the pathological division, to extract from scabbed barley the unpalatable and emetic factors. Some success has resulted from these efforts, but thus far it has not been possible to remove the objectionable principles completely, so as to make scabbed barley wholesome and palatable for hogs.

One phase of a test has been made to determine the efficiency of barleys of different weights per bushel in terms of standard No. 2 yellow corn when fed to hogs. Assuming 9 parts of No. 2 yellow corn and 1 part of 60 per cent animal tankage to represent 100 per cent efficiency in feeding 100-pound shotes, the test demonstrated that barley weighing 48.5 pounds a bushel was 93.5 per cent efficient, barley weighing 45 pounds a bushel 87.3 per cent, and barley weighing 42 pounds a bushel 86 per cent when used in the proportion of 9 parts of barley to 1 part of 60 per cent tankage.

Carcass gradings of these hogs were in accord with the usually accepted belief that, in comparison with corn, barley produces firm hog carcasses.

A second phase of this test is now in progress, and is intended to show the efficiency of light, medium, and heavy barley in comparison with corn on growth and development of pigs.

FIELD STATIONS

At Miles City, Mont., work on the project for the production of hogs that will make Wiltshire sides acceptable to the English market was continued.

In the Wiltshire test the spring pigs of 1929 were fattened on the same feeds as heretofore, namely, barley and tankage on alfalfa pasture. When ready for market they were shipped to Milwaukee where they were slaughtered and a representative lot of Wiltshire sides processed and shipped to England for sale.

The report on this shipment was the first complete report obtained since the experiment was begun. It shows that equally good Wiltshires were produced from Chester Whites as from Yorkshires or crosses between these breeds. Some of the carcasses in each lot sold for the highest price received for any in the shipment, while some in each lot sold for the lowest price. The firm to which this shipment was made was pleased with the sides and reported that it was the best lot of that brand of Wiltshires ever received at that port and quite equal to the best brands of Canadian bacon.

HORSE INVESTIGATIONS

Horse investigations were continued at the bureau's two principal horse-breeding stations, the United States Morgan Horse Farm, Middlebury, Vt., and the United States Range Livestock Experiment Station, Miles City, Mont. In addition, work was begun in a study of growth of colts at the United States Animal Husbandry Experiment Farm, Beltsville, Md. Cooperative contacts were maintained with the War Department in continuing investigational and remount breeding work, also with the Storrs Agricultural Experiment Station, Storrs, Conn.

Farm-power studies were continued in cooperation with the Bureau of Agricultural Economics, the Bureau of Public Roads, and 11 States in conducting a survey on the farm-power situation in different areas. The data are being compiled by the cooperating bureaus.

UNITED STATES MORGAN HORSE FARM

The projects at this farm were continued along the same lines as in preceding years, the principal subjects of investigation being: Factors relating to the breeding, feeding, and management of light horses; vertebrae studies; and the correlation between the period of pregnancy of mares and the season of foaling. The work in light-horse investigations is being conducted with a stud of about 60 purebred Morgan horses. This year's foal crop was 14, of which 5 are males and 9 are females. Surplus breeding stock was sent during the year as far as California, Nevada, Montana, and the Virgin Islands. The demand still exceeds the supply. The quality of animals produced at this farm is exceptionally high. The foals produced during the year were very uniform. Birth weights had the small range of from 96 to 116 pounds, and the heights for the same foals were between 36½ inches and 39½ inches.

UNITED STATES RANGE LIVESTOCK EXPERIMENT STATION

The horse investigations at this station continued to deal with the production and management of purebred and grade horses of the draft and light types under range conditions. A stud of approximately 175 animals was maintained. Work now in progress consists in obtaining data on the use of various-sized teams for ranch work, feeding trials with draft and light colts, and internal-parasite studies in cooperation with the zoological division of the bureau.

CERTIFICATION OF ANIMALS IMPORTED FOR BREEDING PURPOSES

Under the provisions of paragraph 1506 of the tariff act of 1922 the bureau issued certificates of pure breeding for 446 horses, 8,257 cattle, 2,540 sheep, 5 swine, 1,567 dogs, and 28 cats, making a total of 12,843 certifications during the year.

POULTRY INVESTIGATIONS

POULTRY BREEDING

Studies in the inheritance of egg production and egg size were continued with Barred Plymouth Rocks, White Leghorns, and Rhode Island Reds. In the latter breed two hens laid 301 eggs each, a new high record for this breed at the United States Animal Husbandry

Experiment Farm at Beltsville, Md. The average egg production, per bird, of the breeding pens has been maintained at a high level, the Rhode Island Reds increasing from 235 to 243 eggs. The number of hens making good second-year records is gradually increasing. One of the best Rhode Island Red hens, from a breed standpoint, laid 230 eggs in her second year.

The percentage of fertile eggs in the Barred Rocks was 95.54; in the Rhode Island Reds, 83.04; and in the Leghorns, 90.31. Fertility in the Rocks and Leghorns showed considerable improvement over the previous year. In the Rhode Island Reds there was a slight decrease in fertility due to selective mating in two breeding pens.

In the Barred Plymouth Rocks the percentage of hatchability of fertile eggs set was 66.53; in the Rhode Island Reds, 74.22; in the White Leghorns, 67.76. All three breeds showed a higher percentage of hatchability than in the previous year. Progress in improvement in hatchability can probably be ascribed to selection, as excellent results were obtained from pens of high-hatching ancestry.

Studies of hatchability in full-brother-and-sister matings and half-brother-and-half-sister matings in Leghorns and Barred Rocks indicate that hatchability decreases as close inbreeding is continued. This decrease was greater in the Barred Rocks than in the Leghorns. Continuous full-brother-and-sister matings were shown to be more detrimental to hatchability than full-brother-and-sister matings alternated with half-brother-and-sister matings.

Partridge Plymouth Rocks and White Leghorns inbred for egg size and shape have been intercrossed to study inheritance of these characters. Crosses of Black and White Rose-Comb Bantams show dominance of the former color. Inheritance of comb and crest characters, vulture hocks, and hen feathering are being studied in pens of Plymouth Rock varieties, the Silkie-White Leghorn hybrid, and the original Brown Leghorn-Golden Spangled Hamburg cross.

POULTRY FEEDING

In an experiment with fish meal, desiccated meat meal, and shrimp bran, the most efficient growth was obtained from the meat meal, with very good growth on two kinds of fish meal, and with the least efficient results from the shrimp bran. Results obtained on the effect of alfalfa meal on the growth of chicks showed no advantage in feeding more than 5 per cent of the product, while over 12.5 per cent may have a slightly deleterious effect on growth.

A continuation of the study of the relative value of ultra-violet irradiation and cod-liver oil for hens confined indoors gave an egg production roughly in the ratio of 2:1:3 for the irradiated birds, the control birds, and the birds receiving cod-liver oil, respectively.

Continued progress is being made in the project on growth and fattening rations, in which the effect of various additions to a basal diet of corn meal and dried buttermilk is being studied.

A new project containing an extensive series of tests of the effect of diet on the production, size, composition, vitamin content, and hatchability of eggs is still in progress. Buttermilk and the animal proteins have given good production and hatchability, while some of the vegetable proteins, especially cottonseed meal, have materially

reduced both egg production and hatchability. A detailed study of the effect of these feeds on the growth and development of the chick embryo is being made.

Experiments in incubation, extending over a period of years, have determined the optimum conditions for four physical factors influencing incubation. The results of this work are being prepared for publication.

Breeding experiments at the United States Poultry Experiment Station, Glendale, Ariz., have resulted in greatly improved egg production in Rhode Island Reds and White Leghorns. Experiments have shown that the early feeding of baby chicks is not detrimental to yolk absorption and development, as has been commonly believed. Good results, for two years, have been obtained in keeping hens in that section without any housing.

Turkey investigations have been begun at the United States Range Livestock Experiment Station, Miles City, Mont., where 600 turkeys were raised and data obtained on growth rate and production costs, both with range and confinement methods.

BIOCHEMIC DIVISION

The work of the Biochemic Division, under M. Dorset, chief, consisted for the most part of chemical and bacteriological researches on problems concerning meats and meat food products, dips and disinfectants, tuberculin and mallein, and hog cholera.

MEATS AND MEAT FOOD PRODUCTS

RELATION OF THE GROWTH-PROMOTING VITAMIN G TO THE ANTIPELLAGRA VITAMIN

The study of the vitamin G content of certain foods which had previously been tested by Doctor Goldberger and associates, of the Public Health Service, for value in the prevention of pellagra, has been continued and completed. The results are being assembled for publication. In general, it may be stated that the antipellagric potency as determined by Goldberger is not a guide to the growth-promoting vitamin G content of foods as determined by feeding tests with rats. Certain foods which Goldberger found to be of only slight potency in preventing pellagra are well supplied with the growth-promoting vitamin G. These results seem to indicate that vitamin G, which promotes growth in rats, is not identical with the antipellagric factor of Goldberger.

STUDY OF CANNED HAMS AND OTHER CANNED AND CURED PORK PRODUCTS

During the year there was begun, in cooperation with the Meat Inspection and the Pathological Divisions of the Bureau, a comprehensive study of methods used by packing establishments in the canning of cured pork meats. The investigation has included a study of the methods of procedure, including slaughter, curing, and canning of these meats at 12 packing establishments engaged in the production of these classes of canned meat. In addition, samples of the commercial products have been collected and are being subjected to chemical, physical, and bacteriological investigation. A study is

also being made of the keeping qualities of the various products when subjected to unfavorable temperature conditions. This work has not progressed far enough to warrant conclusions.

INVESTIGATIONS OF DIPS AND DISINFECTANTS

Routine laboratory analyses were made of 118 samples of dips, disinfectants, viruses, serums, and miscellaneous products.

FIELD TESTS FOR DIPPING BATHS

During the year there were prepared and forwarded to inspectors in the field the following: For testing the strength of dipping baths, 324 new outfits for arsenical dips and supplies to make 368,000 field tests; 22 new outfits for testing lime-sulphur dipping baths and supplies to make 5,300 field tests; 12 new outfits for testing nicotine dipping baths and supplies sufficient to make 4,145 tests; and supplies sufficient to make 4,400 tests for phenol in viruses, serums, and analogous products.

STUDIES OF DISINFECTANTS

The investigations concerning the action of chlorine in the disinfection of tannery effluents have been continued. Conditions necessary for the formation of the mono and dichloro derivatives of methylamine and glycine were worked out. These four substances, together with the two chloroamines from ammonia, nitrogen trichloride, and chlorine in acid and alkaline solution, have been tested against anthrax spores and the results published. Nitrogen trichloride and chlorine in acid solution proved to be the most powerful against anthrax spores. The two chloroamines and the dichloro derivatives of methylamine and of glycine were moderately effective while the monochloro derivatives of methylamine and of glycine were least effective. On the basis of these differences in germicidal power attempts are being made to develop a practical field test. A comprehensive study of the influence of the reaction of the solutions is also nearly completed.

Extensive laboratory and field work was conducted during the year on the effect of various preservatives on the sensitiveness of antigens for use in testing fowls for pullorum disease. This work is progressing satisfactorily.

INVESTIGATIONS OF ANTHELMINTICS

The investigations of anthelmintics, in cooperation with the Zoological Division, were continued. A widely used anthelmintic, tetrachlorethylene, is subject to decomposition on standing. One of the products of decomposition is phosgene. Investigations have shown that this decomposition may be almost entirely prevented by adding any one of a number of substances, such as phenol, toluene or kerosene, to the tetrachlorethylene in the proportion of 0.1 per cent. It has also been found that an excess of water sufficient to form a 1-inch layer over the tetrachlorethylene decomposes and removes the phosgene from the tetrachlorethylene, thus preserving

the comparative purity of the latter. Since phosgene is poisonous, this work should be of considerable value to those using tetrachloroethylene as an anthelmintic.

TUBERCULIN AND MALLEIN

The preparation and distribution of tuberculin and mallein for official use by the bureau and State inspectors were continued. During the year the total quantity of mallein supplied was 9,410 doses, which was slightly more than half the amount supplied during the preceding fiscal year.

PRODUCTION OF TUBERCULIN

The year's output of tuberculin was as follows: Subcutaneous tuberculin, 331,540 cubic centimeters; intradermic tuberculin, 1,810,150 cubic centimeters; ophthalmic tuberculin, 2,582,640 disks.

The total production of tuberculin in all forms during the year was 11,716,275 doses.

RESEARCH WORK

The development of a synthetic culture medium for *Mycobacterium tuberculosis* was discussed in the last report. During the fiscal year there were produced and supplied to inspectors for experimental testing 587,775 doses of tuberculin produced from this synthetic medium. The results on the whole have been encouraging and it is believed that eventually this form of tuberculin may replace the old tuberculin which is now regularly employed in eradication work and which has been in use for so many years.

In conjunction with this experimental work the chemical study of products of *M. tuberculosis* on the synthetic medium has been continued, with the result that a complex carbohydrate has been separated from the culture fluid. This carbohydrate appears to be without ability to produce the tuberculin reaction. By chemical methods the complex carbohydrate has been broken up into its component parts and two sugars, *d*-mannose and *d*-arabinose, have been isolated and identified by appropriate chemical tests.

During the year one of the large producers of bacteriological chemicals undertook, at the division's suggestion, to produce asparagine from the seedlings of *Lupinus albus*. If this commercial attempt to produce asparagine is successful it will afford a domestic supply of asparagine which heretofore has been lacking.

HOG-CHOLERA INVESTIGATIONS

During the year there were prepared at the experiment farm at Ames, Iowa, 53,750 cubic centimeters of anti-hog-cholera serum and 34,779 cubic centimeters of virus. These products were used in connection with the various hog-cholera experiments in Iowa, near Washington, D. C., and in cooperation with the Animal Husbandry Division for the immunization of suckling pigs at eight farms in different parts of the country. The immunization of the suckling pigs proceeded satisfactorily, as has been the general experience. As in previous years, a limited amount of field work was carried out in Iowa mainly for the purpose of investigating so-called "breaks" in immunity following the serum-virus treatment for hog cholera.

STUDIES OF VACCINES

During the year an attempt was made to prepare a vaccine for hog cholera, following as nearly as possible the method which Laidlaw and Dunkin reported to have been successful in the preparation of a vaccine for dog distemper. For this work a vaccine was prepared from livers, spleens, and mesenteric glands of two hogs affected with cholera. The attenuating agent was formaldehyde in the proportion of 0.1 per cent.

After storage for eight days in the ice box, the vaccine prepared in this way was found to be capable of giving rise to symptoms of disease when injected in doses of 10 cubic centimeters. After 28 days the vaccine produced no reaction. Pigs treated with two lots of the vaccine, 28 and 46 days old, respectively, after preparation, were subjected to a reinforcing injection of 0.1 cubic centimeter of hog-cholera virus after an interval of approximately two weeks, this procedure being in conformity with the method of Laidlaw and Dunkin. The results of the test were disappointing, since all the animals showed a severe form of cholera following the reinforcing injection of virus.

STUDIES OF DISINFECTANTS FOR HOG CHOLERA

Several years ago experiments were begun to develop, if possible, a better preservative for serum than that now used. Among the substances tested was ordinary ether. The ether was added to defibrinated virus blood in the proportion of 4 cubic centimeters of ether to 100 cubic centimeters of blood. The bottles containing the ether-virus mixture were sealed and held at ice-box temperature. Tests of virulence were made from time to time by injecting susceptible pigs, some with the virus preserved with ether and others with the same virus preserved with one-half of 1 per cent of phenol. These two lots of virus blood were tested, respectively, after 145 days', after 265 days', after 428 days', and after 648 days' storage. The virulence of these two lots of virus remained apparently unchanged for 428 days. When tested at 648 days, however, both samples had lost their power to produce disease. Bacterial counts were made from time to time and were somewhat higher in the virus preserved with ether, but there was not a great difference in this respect. Studies along this line will be continued.

A fairly extensive series of experiments was carried out to determine the value of sodium hydroxide and combinations of sodium hydroxide with milk of lime on the virus of hog cholera. For the most part the experiments were carried out by taking various amounts of disinfectants and definite quantities of fresh, defibrinated, virus blood, allowing the mixtures to remain at room temperature for different lengths of time and then injecting the mixtures of virus blood and disinfectants into susceptible pigs. In the experiments the sodium hydroxide varied in strength from 0.5 to 4 per cent while the milk of lime was in most cases 2 per cent. In this strength the lime was found to be sufficient to give a distinct, white coating to surfaces to which the disinfectant was applied. Three per cent

sodium hydroxide in combination with 2 per cent milk of lime killed the virus of hog cholera in defibrinated blood within 15 minutes. In one experiment where finely ground liver tissue was exposed to the action of 1 per cent sodium hydroxide and 2 per cent milk of lime for two hours, the virus was not destroyed. It seems likely that considerable time is required for this disinfectant to penetrate the masses of tissue cells.

STUDIES OF SERUM-VIRUS MIXTURES

In continuation of this work, which had already been begun in the previous year, attempts have been made to control the results of the preceding year. In the present experiments serum and virus were mixed *in vitro* in the proportion of 10 to 1. Pigs were injected subcutaneously with doses of 1 cubic centimeter of the mixture.

Control pigs at the same time received an equivalent amount of serum and virus administered separately but simultaneously. In this way it was demonstrated that the quantity of serum used was not enough to protect when the serum and virus were given separately and also that the amount of virus (0.1 cubic centimeter) was sufficient to bring the pigs down promptly with cholera. These experiments again point strongly to the neutralization of virus by serum *in vitro*.

In another series of experiments the results were not so uniform. The cells from virus blood were separated by centrifuging, washed with normal salt solution, and then subjected to the action of serum. Later the serum was removed by centrifuging and the cells tested for disease-producing power. In some cases they were capable of producing disease. In others where the work was carefully controlled, there appeared to be complete neutralization of virus, although red blood cells, washed in the same way but not subjected to the action of serum, were capable of producing hog cholera. Certain experiments have shown that the virus of hog cholera is rather abundant in certain of the organs. An attempt was made to neutralize the virus contained in finely ground spleen tissue by exposing it to the action of hyperimmunizing serum. Neutralization was not successful, this being attributed to the fact that the tissue could not be divided finely enough to obtain contact of the serum with all the parts. Thus the virus was not neutralized.

DISTRIBUTION OF VIRUS IN HOG-CHOLERA BLOOD

An attempt has been made to study the distribution of virus in the several elements of the blood. This work has presented considerable difficulty and it is expensive owing to the large numbers of pigs required. These factors have delayed completion of the studies. However, sufficient work has been done to indicate that a relatively small part of the virulence of virus blood passes into the serum, most of the virus being associated with the cellular elements. The preponderance of evidence indicates that most of the virus is associated with the red cells, and it is strongly suggested that most of it may be associated with the stroma.

DISTRIBUTION OF VIRUS IN TISSUES OF CHOLERA PIGS

These experiments were carried out in conjunction with similar experiments with the blood. The tissues used were suspensions of livers, kidneys, and lymphatic glands removed from pigs suffering with hog cholera, which had been killed on the eighth and ninth days after infection. The tissues were finely ground, handled in an aseptic manner, and finally suspended in sterile, physiological salt solution. The suspensions were diluted and administered subcutaneously to susceptible pigs in doses equivalent, respectively, to one one-hundred-and-fifty-thousandth, one three-hundred-and-fifty-thousandth, and one four-hundred-and-fifty-thousandth of a gram in the different tissues. The suspensions of liver and of spleen tissue proved to be infectious in a dose of one four-hundred-and-fifty thousandth gram. In the case of the kidney tissue, one three-hundred-and-fifty-thousandth of a gram was found to be infectious, while the gland tissue failed to cause disease in the lowest dose employed, namely, one one-hundred-and-fifty-thousandth of a gram.

The results were not always regular because in some instances the liver tissue produced disease only in the larger of the above-named doses. It may be inferred from these experiments that the livers and spleens of virus pigs contain the disease-producing agent in large amounts.

USE OF TISSUE SUSPENSIONS FOR HYPERIMMUNIZING

Recent studies of the distribution of virus in the tissues of cholera pigs showed that certain tissues, notably liver and spleen, contain large amounts of virus. Suspensions of such organs finely ground were used experimentally for hyperimmunization. The finely ground tissues were suspended in a solution of salt and glycerin. The immunes were hyperimmunized by subcutaneous injection since the suspensions were of such a character that they could not be injected intravenously. The anti-hog-cholera serums obtained in this manner were found to possess considerable potency but yet were not so potent as serums produced after hyperimmunization in the regular manner by means of defibrinated virus blood. Furthermore, the subcutaneous injections were the cause of extensive abscesses and the hyperimmunes did not gain normally in weight. Although it is possible to produce a moderately potent serum in such a manner, there are serious objections to the method.

USE OF MUSCLE EXTRACT FOR HYPERIMMUNIZATION

Since the muscular tissue contains virus, considerable quantities of such tissue removed from virus pigs were finely ground and mixed with normal salt solution in the proportion of 1 cubic centimeter to each gram of tissue. The mass thus produced was frozen overnight and then allowed to thaw. Somewhat more than a liter of juice was obtained from the mixture made from 3 pounds of muscle tissue. By filtering with infusorial earth through paper a perfectly clear material was obtained. This was used for hyperimmunizing hogs by intravenous injection. In some cases serum of excellent potency was obtained by this method. In other instances the serum was less

potent than that obtained by the use of defibrinated virus blood for hypering. Experiments along this line are being continued, along with certain other studies of the dose of defibrinated virus blood required to produce a serum of high potency.

DIAGNOSIS OF HOG CHOLERA BY LEUCOCYTE COUNT

A large number of counts of the white blood cells in normal pigs and in pigs affected with cholera in various stages have been carried out. This work was undertaken in view of the suggestion made by Lewis and Shope that the white-blood-cell count be used for the diagnosis of hog cholera. The division's data indicate that although there is a distinct tendency in hog cholera toward leucopenia, yet there was a very great variation in individual pigs in this respect. In fact, the blood of the same pig was found to vary from day to day. In general, it appeared that a white-blood-cell count of below 8,000 indicates hog cholera very clearly. On the other hand, counts in excess of 8,000 can not be taken as a sure indication of the absence of the disease. These, together with other observations, indicate the limited practicability of the method.

EXPERIMENT STATION

The work of the bureau's Experiment Station at Bethesda, Md., conducted under the supervision of W. E. Cotton, superintendent, has consisted principally in investigations of infectious abortion, tuberculosis, and vesicular stomatitis, and in providing other divisions of the bureau with facilities for experimentation not available in their own laboratories.

INFECTIOUS ABORTION

Preventive vaccination is one phase of the abortion problem against which investigative efforts have been directed. Because of the feeling that the use of abortion vaccine, as at present prepared and employed, constitutes a potential danger not only to cattle but also, through the milk, to mankind, experimental procedures have been pursued to determine whether *Bacterium abortus* (also designated *Brucella abortus*) strains of reduced virulence may not be used in the preparation of abortion vaccine that will confer a serviceable degree of immunity and at the same time rarely or never become established in the vaccinated animal. Approximately 150 heifers and cows have been used to gain more definite information on this subject. In one of these experiments a *Bact. abortus* strain of so greatly reduced virulence that its intravenous injection into susceptible pregnant cows failed to transmit the disease was used in the preparation of vaccine for use during pregnancy. Results thus far obtained from vaccination during the pregnant period with this particular strain have indicated that, while the degree of immunity imparted to susceptible animals by its use is not thoroughly protective against severe *Bact. abortus* exposure, it nevertheless increases the resistance of the animal to the disease.

In experiments with vaccines prepared from *Bact. abortus* strains of varying degrees of virulence, used in connection with susceptible, unbred cows and heifers, the results suggest that localization of the

vaccine and establishment of the infection in the udders of the vaccinated animals may bear a rather definite ratio to the virulence of the *Bact. abortus* strains with which the vaccines are prepared. A vaccine prepared from the third transfer of the microorganism localized in the udders of unbred cows with regularity. The infection could be isolated from their milk for prolonged periods. Udder infection was induced less regularly with a vaccine prepared with a *Bact. abortus* strain that was longer under artificial cultivation; and a vaccine prepared with a *Bact. abortus* strain so reduced in virulence as to appear nonpathogenic for guinea pigs gave indication, when subcutaneously injected, of being noninfective for unbred susceptible cows. While these experiments involving the use of vaccines of varying degrees of virulence have not been concluded, the results suggest that the degree of immunity conferred by vaccination may not be entirely governed by the degree of virulence of the *Bact. abortus* strains with which the vaccines are prepared.

The vaccination of animals during calthood received further consideration during the year. Eight cows vaccinated during calthood and which have since received no further immunization treatments have now been carried through their third pregnancies. During this third gestation period the manner of *Bact. abortus* exposure employed was of such severity as to cause six of the seven animals used as controls in the experiment to abort. However, but one abortion occurred in this group of eight cows which were vaccinated when calves. In six of them *Bact. abortus* could not be demonstrated as being present in the colostrum or in the placental emulsions at times of calving through guinea-pig-inoculation procedures. The presence of *Bact. abortus* in the colostrum of one animal which gave birth to a vigorous calf was established, and the infection was also demonstrated as being present in the colostrum and in the placenta of the single animal which aborted. A paper descriptive of this calthood-immunization experiment covering two gestation periods was prepared for publication. The results of this original calthood immunization experiment were sufficiently encouraging to prompt the use of 35 additional calves in an experiment now being conducted along similar lines.

In the preceding annual report attention was directed to the observation that infectious abortion could be transmitted to susceptible pregnant bovines by depositing on the mucous membrane of the eye three or four drops of a heavy suspension of the abortion microorganism and that this method of exposure, when used together with exposure by way of the digestive tract, appeared to constitute a simple and reliable means of determining the existence of immunity in vaccinated subjects. Further use of this conjunctival method of exposure has revealed that it does not need to be supplemented by ingestion exposure but can be depended on alone to transmit the disease to susceptible pregnant cows and heifers with regularity, thereby simplifying to a considerable degree the matter of furnishing *Bact. abortus* exposures in vaccination experiments.

The transmission of abortion disease through the skin has also been subjected to further experimentation. Results have definitely indicated that by depositing small quantities of *Bact. abortus* suspensions on comparatively small, slightly abraded, areas of the skin

of susceptible pregnant heifers, the transmission of the disease can be readily accomplished. Results have also indicated that in the case of susceptible pregnant heifers the infection does not necessarily require an abraded surface of the skin to gain entry to the animal's uterus and udder and cause the act of abortion, but has appeared to be capable of penetrating the unbroken skin as well. The results of these transmission experiments have been much in accord with those previously reported by A. V. Hardy, of the United States Public Health Service, in connection with the transmission of the disease to laboratory animals.

Efforts have been made to gain more definite information as to the virulence of porcine strains of *Bact. abortus* for cattle, and of bovine strains of the microorganism for swine. While it has been possible with a recently isolated porcine strain, through conjunctival exposure, to transmit abortion disease to pregnant heifers, this variety of the organism has appeared to be less active than the bovine type in inducing the act of abortion in this species of animal. Failure thus far experienced in demonstrating that the bovine variety of the microorganism can be established in swine by either conjunctival exposure to recently isolated bovine strains or by the feeding of *Bact. abortus* infected bovine fetuses to them, has suggested that for swine the bovine variety of the abortus microorganism may not be markedly pathogenic.

Guinea-pig inoculations of blood serum from reacting swine have given results of such a character, in a few instances, as to suggest that *Bact. abortus* of the porcine variety may at times invade the blood stream of infected swine. Inasmuch as attempts to isolate *Bact. abortus* from the blood stream of infected cattle have been attended with failure so many times the guinea-pig-inoculation results with the blood serum of reacting swine are of unusual interest. This matter is receiving further consideration.

Efforts have been directed toward gaining more definite knowledge regarding the significance of agglutination reactions of different titers to abortion disease in cattle. Milk samples were procured from each quarter of the udders of 41 cows which gave blood-serum reactions of different titers to the disease. Two guinea pigs were inoculated with milk obtained from each quarter of the udder. The inoculation results revealed that all 14 of the cows from which milk was procured that reacted in a titer of 1 to 2,000 or higher carried the infection in their udders. The results, furthermore, indicated that 9 of these 14 animals were eliminating the abortion microorganism in all four quarters of their udders. The presence of *Bact. abortus* infection was demonstrated in 9 of the 10 cows which gave a blood-serum reaction of 1 to 1,000, in 3 of the 7 cows with an agglutination titer of 1 to 200, and in the single cow which reacted in a titer of 1 to 100. Failure was experienced in demonstrating the presence of the abortion germ in the milk of 7 cows reacting in a titer of 1 to 50 and in two cows reacting in a titer of 1 to 25. Studies of this diagnostic phase of the disease are being continued.

A family cow supposedly responsible for a human case of undulant fever was used for studies with reference to the type and virulence of the infection being eliminated in her milk. The results have indicated that the infection present is of the bovine type. While milk

from all four quarters of her udder was found to be carrying the abortion microorganisms, her milk appeared to be no more infectious for guinea pigs than that of infected cows often encountered.

The Experiment Station was enabled during the year to make abortion agglutination tests of samples of blood serum from a small number of elk. Of the six samples tested one specimen from a female animal reacted in a titer of 1 to 200 and one from a male animal in a titer of 1 to 100. These results strongly suggested the susceptibility of this species of animal to infectious abortion.

Cooperative projects on abortion disease were begun with eight State universities or State experiment stations at the beginning of the fiscal year. These projects were so selected as to cover many phases of the problem as well as avoid undue duplication of the work. In a general way the projects include studies relating to diagnosis, control, and eradication, relative productivity of infected and noninfected cows, effects of dietary deficiencies, chemotherapy, immunity, and the carrier problem. These studies will have to be continued for several years before complete results can be expected.

TUBERCULOSIS

The investigations that have been in progress for several years to determine the value of the Calmette B. C. G. vaccine as an immunizing agent are drawing to a conclusion. Several vaccinated cattle and their controls, which received natural exposure over an extended period, have been removed from exposure and are to be kept for a number of months to determine whether the vaccine, though not preventing infection, may prevent it from causing progressive disease.

A considerable number of small experiment animals, injected with large amounts of B. C. G. nearly a year and a half ago, are being permitted to live for a longer period in order to determine whether the time factor has any special significance in connection with the development of tuberculosis lesions in them as a result of the injections. A few of these animals have died from various causes, but none have given evidence of being affected with tuberculosis and the survivors appear to be healthy.

In the preceding annual report mention was made of comparative tests of a strain of the tubercle bacillus which had passed through swine continuously for 15 years and had also been passed through cattle during the same period. The results of this test indicated that there had been no measurable change in the virulence of the microorganisms for swine, whether harbored by cattle or swine, during that prolonged period. The passage of the strain through cattle and swine has been continued and preparations are now being made to conduct a similar test on cattle to determine whether the long sojourn of the microorganism in swine has changed its virulence for the bovine species.

As in former years commercial tuberculins have been tested for potency and purity.

VESICULAR STOMATITIS

The two distinct strains of vesicular-stomatitis virus previously mentioned as having been isolated from different outbreaks of the disease have been preserved for further study by passage through

guinea pigs. One of these strains has undergone 631 transfers in nearly four and one-half years. Within the year an outbreak of the disease occurred in Alabama. The strain of the virus responsible for this outbreak was shown by guinea-pig immunity tests to be the same as the one isolated from a New Jersey outbreak several years ago.

MISCELLANEOUS

A considerable amount of miscellaneous work was performed during the year, particularly in connection with infectious abortion. A voluminous correspondence has borne evidence of the fact that infectious abortion is a matter of unusual importance to livestock owners in general. A large number of experiment animals were raised and all land not occupied by buildings or used for pens has been kept under intensive cultivation to grow feed for them.

FIELD INSPECTION DIVISION

The Field Inspection Division, directed by George W. Pope, chief, continued its activities for the control and eradication of certain animal diseases and the administration of regulations governing the exportation of livestock and those designed to prevent the introduction of disease through livestock, hides, skins, wool, and other animal by-products, feeding materials, fertilizers, used bagging, and hay and straw packing materials entering the United States from foreign countries.

The country very fortunately has continued to be free from foot-and-mouth disease, rinderpest, contagious pleuropneumonia, surra, and fowl pest.

ERADICATION OF SCABIES

In the control and eradication of sheep scabies the bureau continued to cooperate with State livestock sanitary officials and the Office of Indian Affairs. Inspectors in the field made 22,886,382 inspections and supervised 4,450,111 dippings of sheep, representing, in both instances, a considerable increase over the preceding year. Sheep found to be infected numbered 846,389, which is approximately 15 per cent more than for the preceding year. Reports indicate an increase in the number of infected sheep in Arizona, Nebraska, New Mexico, and Wyoming, and a decrease in all other sheep-raising States. No infection was reported in Idaho, Nevada, Oregon, or Washington. During the year all areas in California quarantined for sheep scabies were released with the exception of San Clemente Island.

In the control and eradication of cattle scabies bureau employees made 3,371,764 inspections and supervised 446,086 dippings of cattle in cooperation with State livestock sanitary officials and the Office of Indian Affairs. A total of 89,279 cattle were found to be infected. This is approximately 10 per cent less than during the preceding year. A slight increase was reported in the number of infected cattle in Kansas, Nebraska, Oklahoma, and Washington, and a small

outbreak was reported in Nevada. But on the whole, the cattle-scab situation represented improvement over the preceding year.

The inspection and dipping of goats for scabies were confined principally to Texas and inspectors of the bureau continued to cooperate with the State livestock sanitary authorities. Inspections were made of 224,286 animals, 6,612 of which were found to be infected with this disease, and 10,638 dippings were supervised. There were also reported 212 dippings of goats for scabies in Oklahoma.

In the control of horse scabies, chiefly on the Blackfeet Indian Reservation in Montana, 6,462 horses were inspected, 316 were reported infected, and 3,315 were dipped under supervision.

INTERSTATE SHIPMENTS OF LIVESTOCK

During the year 2,509 horses and mules were inspected and 1,172 tested with mallein for glanders by bureau veterinarians in connection with their regular duties. None of the animals reacted to the test, tending to indicate that glanders is now of rare occurrence in the United States. These inspections were made and tests administered for interstate movement, and certificates were issued to conform to the requirements of the livestock sanitary authorities of the States of destination. Inspectors in the field also made other inspections of livestock and issued certificates to conform with State requirements.

ERADICATION OF DOURINE

Inspections and occasional tests of horses in the previously infected area of Montana and on the Navajo Indian Reservation, in Arizona, lend assurance to a belief that dourine has been eradicated from those areas. During the year, however, the disease was found to exist among horses in northern Nevada, including the Western Shoshone Indian Reservation, and on the San Carlos Indian Reservation, in Arizona. Also, small areas in Idaho and Oregon contiguous to the Nevada line were found to be slightly infected.

A general survey which was being made at the close of the year, with tests applied to a limited number of horses, indicated a probable general infection of horses on the San Carlos Reservation and possible involvement of the adjacent Apache Indian Reservation. It was revealed that at least half of the horses on the first-mentioned reservation were small wild animals practically worthless and almost impossible to gather for testing or removal from the range. In view of the rough topography of the country this condition presents certain difficulties which must be met in any future plans for eradication of the disease in that area.

During the last three months of the year, eradication work was conducted in the various northern counties of Nevada in cooperation with the livestock sanitary authorities of that State. Of the horses subjected to test, less than 3 per cent reacted. While the disease was probably eradicated from a number of ranches, elimination of infection in horses on the range was not accomplished. This was due

largely to failure to effect a satisfactory round-up and test all horses including wild and worthless ones running at large.

As the result of tests applied in cooperation with the Idaho and Oregon State authorities, four reacting horses were found in Idaho and seven in Oregon in areas of those States just north of the Nevada boundary line. The number of animals tested and the results of the tests are recorded on page 54.

CONTROL OF COMMUNICABLE POULTRY DISEASES

No outbreak of fowl pest or similar serious disease of poultry was reported during the year. As a precautionary measure, however, the bureau continued to supervise the cleaning and disinfection of cars used in the interstate transportation of live poultry. Cars so treated during the year numbered 11,839, the work being chiefly performed at three central disinfecting stations. Although this service was begun as a means of eradicating a previous outbreak of fowl pest, it has proved to be a useful sanitary measure and is well received by the poultry industry.

INSPECTION AND QUARANTINE OF IMPORTED ANIMALS

All horses, cattle, other ruminants and swine presented for entry at coast or border ports were inspected and subjected to quarantine and test or tests as required by the regulations. While it has been an administrative rule of the department to issue no permits for the importation of cattle, other domestic ruminants and swine from countries infected with foot-and-mouth disease or other serious disease of livestock, an act of Congress was passed during the year specifically prohibiting by law the importation of any such animals from a country in which either foot-and-mouth disease or rinderpest exists.

As a result of the prevalence of foot-and-mouth disease in Europe and existence of the cattle tick in Central America and the West Indies, importations of cattle, sheep, goats, and swine were practically limited to those from Canada, Mexico, Great Britain, and the Channel Islands. Cattle from the Channel Islands were imported at intervals throughout the year, and as England apparently had suppressed the outbreak of foot-and-mouth disease that occurred in December, 1929, the department in March resumed the issuance of permits for cattle and sheep from Great Britain. This enabled several importers in the United States to effect the shipment of animals which, in some instances, had been held in England or Scotland for several months awaiting an opportunity for their importation into the United States.

The animal-quarantine stations at the ports of Boston, New York, and Baltimore were maintained in good condition throughout the year. The number and kinds of animals imported are shown in Tables 2 and 3.

TABLE 2.—*Imported animals inspected but not quarantined, fiscal year 1930*

Port of entry	Cattle	Swine	Sheep	Goats	Horses and mules	Asses	Other animals
Baltimore.....					3		
Boston.....				2	55	6	
Galveston.....					9		
Key West.....					576		
Los Angeles.....					67		
New York.....					1,025	27	16
Philadelphia.....					2	1	
San Francisco.....					17		
San Jaun, Porto Rico.....	1,797	70		4	76	1	3
Tampa.....					5		
Canadian border ports.....	189,768	2,047	5,369	34	6,566		420
Mexican border ports.....	216,268	1	5,963	96	7,828	1	52
Total.....	407,833	2,118	11,332	136	16,229	36	491

¹ Of this number 5,566 were mules.

NOTE.—Mexican animals passed through United States territory under bond for return to Mexico and inspected at the time of entry were as follows: Cattle, 1,657; sheep, 300.

TABLE 3.—*Imported animals inspected and quarantined, fiscal year 1930*

Port of entry	Cattle	Swine	Sheep	Goats	Horses and mules	Asses	Other animals
Baltimore.....	39		86				3
Boston.....	52		68				47
Charleston, S. C.....				4			
Hawaiian Islands.....			10		15		10
New Orleans.....			10				13
New York.....	879		22			1	76
San Juan, P. R.....			6				
San Francisco.....			23		23		1
Los Angeles.....							9
Canadian border ports.....	302	32	1	1			
Mexican border ports.....							
Total.....	1,272	32	226	5	38	1	159

In addition to cattle shown in Table 2, 3,086 head from Mexico were refused importation owing to infestation by ticks, or exposure to them, and 1,935 head were rejected for scabies infection.

All the 970 cattle shown in Table 3, as imported at Baltimore, Boston, and New York, were subjected to and passed a satisfactory tuberculin test while in quarantine.

Eighty-four cattle from Canada were rejected for importation through failure to pass a satisfactory tuberculin test at the port of entry.

Aside from cattle from Canada and Mexico and those entering Porto Rico from the Virgin Islands, the cattle imported were limited to those from Great Britain and the Channel Islands. Sheep other than those from Canada and Mexico consisted of breeding animals from Great Britain, Australia and New Zealand in addition to 10 Karakul sheep from Cuba and 7 sheep from Panama for zoological-garden exhibition purposes.

Especial attention was given to the regulation prohibiting vessels from entering ports of the United States with sea-stores livestock originating in regions where foot-and-mouth disease or rinderpest exists. In the administration of this order the bureau continued to

receive full cooperation from boarding quarantine officers and customs officials of the Treasury Department. During the year, 30 vessels were found to be carrying prohibited livestock and were held pending slaughter of the animals and disinfection of that portion of the vessel occupied by them. These animals consisted of 2 cattle, 30 swine, 25 sheep, and 2 goats, making a total of 59 animals. During the previous year 41 vessels carrying 87 head of prohibited animals were involved.

IMPORTATION OF ANIMAL BY-PRODUCTS, FEEDING MATERIALS, ETC.

Regulations governing the sanitary handling and control of import hides, skins, wool, other animal by-products, hay, feeding materials, etc., were carefully administered to prevent the introduction into the United States of anthrax, foot-and-mouth disease, and rinderpest. The products covered by these regulations are varied. They enter the United States in large measure from countries in which foot-and-mouth disease exists and are of a character considered most likely to harbor infection. It is, accordingly, gratifying that while allowing for their uninterrupted importation the regulations have afforded protection against the introduction of this disease.

These restrictions on the movement and handling of hides and various other animal by-products after arrival in the United States have also served to protect domestic livestock from anthrax. There is no record of the infection of animals or of the contamination of streams and lands with anthrax during the year from tanneries handling restricted import hides and skins or from plants receiving restricted wool, hair, and other animal by-products.

Owing to danger incident to the landing and feeding of garbage obtained from vessels arriving at United States ports with supplies of fresh or frozen meat obtained in a region in which foot-and-mouth disease exists, great care was taken in the enforcement of an order of the department issued in January, 1929, against the landing and feeding of any such material. In view of the possibility also that the feet of dressed poultry from infected countries might be added to garbage and be used in the feeding of swine, an order, effective August 1, 1929, requiring removal and destruction, or disinfection, of the feet of all such poultry has been carefully enforced. During the year the feet of turkeys in three consignments and of guinea fowls in one consignment were removed and incinerated at the port of entry.

During the year 8,568 railroad cars used in the transportation of restricted import materials were cleaned and disinfected.

INSPECTION OF ANIMALS FOR EXPORT

A careful inspection has been made of all export livestock and, as contemplated by a recent amendment to the law, this inspection has been extended to cover live poultry. All vessels carrying livestock have been inspected in order to assure space and equipment suitable for the safe transport of animals as contemplated by the regulations. In addition to bureau requirements, inspections and tests have been made to meet especial demands of receiving countries. Under a cooperative agreement with the Canadian authorities, tuberculin and mallein tests respectively were applied to practically all dairy or breeding cattle and horses destined to Canada. In addition,

sheep for shipment to Canada were inspected and in many instances dipped. Certificates were issued stating that swine destined to the same country were immunized against hog cholera or had not been exposed to that disease.

The number of animals of various kinds inspected for export is shown in Table 4.

TABLE 4.—*Inspection and testing of animals for export,¹ fiscal year 1930*

Kind of animals	To Canada	To other countries		Total
		American animals	Canadian animals ²	
Cattle.....	633	680	159	1,472
Swine.....	6	345	-----	351
Sheep.....	18,972	959	30	19,961
Goats.....	15	77	-----	92
Horses.....	1,034	537	-----	1,571
Mules.....	48	1,195	-----	1,243
Asses.....	-----	-----	-----	-----
Other animals.....	-----	-----	-----	-----
Total.....	20,708	3,793	189	24,690

¹ In addition, inspections were made and certificates issued on request of owners for the following fur-bearing animals: 1,073 minks and 16 foxes for Sweden; 2 minks and 6 foxes for Germany; 242 minks for Canada.

² Animals of Canadian origin exported through United States ports.

DIVISION OF HOG-CHOLERA CONTROL

During the year efforts to control losses from hog cholera were continued under the supervision of U. G. Houck, chief of the division, in cooperation with State livestock officials, farmers' organizations, and practicing veterinarians.

The year just closed was noteworthy for the small extent of hog cholera in the principal areas of swine production. In all sections of the country the prevalence of hog cholera has been comparatively low and in many States losses from cholera are rated as secondary in the destruction of swine.

The work of controlling the disease was carried on along lines similar to those of previous years. As heretofore, the chief factor in the prevention of the disease was the use of the preventive-serum treatment. Meetings and demonstrations were held, reported outbreaks were investigated, surveys made, and general advice in prevention given to swine owners. The entire time of approximately 36 veterinarians was devoted to control work.

During the year 4,162 outbreaks of hog cholera were reported, which is a material reduction from the corresponding number, 7,029, last year. In the course of investigation, 1,809 cases of the disease were diagnosed, 677 premises were quarantined under State laws, and 345 premises were cleaned and disinfected under the supervision of Federal or State inspectors.

A total of 26,858 farm visits were made during the year for the purpose of investigation, survey, and giving information relative to hog-cholera control. Meetings attended numbered 1,625, at 708 of which addresses were given.

Among other activities bureau veterinarians interviewed 158,139 swine owners and others relative to the more complete control of hog cholera. Demonstrations in the use of anti-hog-cholera serum as

a preventive were given in 1,740 instances. All these activities were in cooperation with State authorities engaged in the suppression and eradication of animal diseases. The work extended to 924 counties in 31 States. Table 5 gives a further summary of the year's activities.

TABLE 5.—*Summary of hog-cholera-control work, fiscal year 1930*

State	Bureau veterinarians engaged in work ¹	Meetings addressed	Premises investigated	Demonstrations		Autopsies performed	Farms quarantined or carded	Farms cleaned and disinfected	Outbreaks reported to bureau veterinarians
				Number	Hogs treated				
Alabama.....	1	31	985	25	432	11			7
Arkansas.....	1.33	21	653	14	225	71		15	312
California.....	.33		24	1	10	17	4	2	8
Colorado.....	1	65	287	9	601	49			33
Florida.....	1.5	21	848	253	6,965	54		3	86
Georgia.....	1.33	12	1,203	98	2,149	45			186
Idaho.....	.33	23	908	25	1,093	61	21	10	26
Illinois.....	3	34	2,373	32	1,466	635	173	269	615
Indiana.....	2	46	1,279			206	17		160
Iowa.....	2	73	521	5	311	125			450
Kansas.....	1		1,332	3	28	25			67
Kentucky.....	2	18	1,956	7	366	157		16	83
Louisiana.....	1	3	1,077	96	2,013	21			55
Maryland.....	2	40	2,516	10	191	124	101		307
Michigan.....	2		994	25	2,056	79	5		241
Mississippi.....	1.03	13	1,231	489	4,319	35			35
Missouri.....	1	48	852	6	348	100			165
Montana.....	.05		144			20	33	6	37
Nebraska.....	1	98	219			108			43
North Carolina.....	1	9	599	138	3,568	77	147	2	67
Ohio.....	1	69	688	13	580	115			380
Oklahoma.....	1.5	1	902	5	166	21	33		34
Oregon.....	.5		137	14	369	6	4	4	4
South Carolina.....	1		435	362	5,948	19			154
South Dakota.....	1		85	1	41	106			65
Tennessee.....	1	11	875	20	602	45	79		285
Texas.....	1		509	4	143	21	7	17	109
Virginia.....	1	17	2,192	3	83	28			23
Washington.....	1.1	20	727	5	459	30	11		33
West Virginia.....	.5	22	114	72	470	10	15		46
Wisconsin.....	1	13	193	5	156	84	27	1	46
Total.....	36.5	708	26,858	1,740	35,158	2,505	677	345	4,162

¹ Fractions denote veterinarians devoting part time to hog-cholera work.

MEAT-INSPECTION DIVISION

The work of the Federal meat-inspection service conducted under the direction of R. P. Steddom, chief, showed an increase of 1.4 per cent in the total number of animals slaughtered, as compared with the preceding year, and an increase of 4.4 per cent over the average total number of animals slaughtered during the last 10 years.

GENERAL MEAT INSPECTION

Inspection was conducted at 804 establishments in 259 cities and towns as compared with 801 establishments in 253 cities and towns during the fiscal year 1929. Inspection was inaugurated at 29 establishments and withdrawn from 36, as compared with 27 and 34, respectively, during the preceding year. Inspection was withdrawn from these establishments on account of discontinuance of operation or interstate business. At the close of June 30, 1930, the number of establishments operating under inspection was 768.

ANTE-MORTEM AND POST-MORTEM INSPECTIONS

The ante-mortem and post-mortem inspections are given in Tables 6 to 11, inclusive.

TABLE 6.—*Ante-mortem inspection of animals, fiscal year 1930*

Kind	Passed	Suspected ¹	Con-demned ²	Total
Cattle.....	8,065,912	217,162	3,146	8,286,220
Calves.....	4,472,527	8,463	2,896	4,483,886
Sheep and lambs.....	15,303,286	4,524	7,872	15,315,682
Goats.....	21,877	10	60	21,947
Swine.....	46,582,123	108,753	24,138	46,715,014
Horses.....	136,427	10	248	136,685
Total.....	74,582,152	338,922	38,360	74,959,434

¹ "Suspected" is used to designate animals suspected of being affected with disease or condition that may cause condemnation in whole or in part on special post-mortem inspection.
² For additional condemnations, see Tables 7 to 11, inclusive.

TABLE 7.—*Post-mortem inspection of animals, fiscal year 1930*

Kind	Passed	Condemne ²	Total
Cattle.....	8,221,243	59,535	8,280,778
Calves.....	4,482,129	9,445	4,491,574
Sheep and lambs.....	15,283,989	22,910	15,306,899
Goats.....	21,825	62	21,887
Swine.....	46,553,438	135,422	46,688,860
Horses.....	135,984	453	136,437
Total.....	74,698,608	227,827	74,926,435

Tables 8, 9, and 10 show the diseases and number of condemnations on ante-mortem and post-mortem inspections.

TABLE 8.—*Diseases and conditions for which condemnations were made on ante-mortem inspection, fiscal year 1930*

Cause of condemnation	Cattle	Calves	Sheep and lambs	Goats	Swine	Horses
Blackleg.....	2	1				
Emaciation.....	3	3	3		26	
Enteritis.....					8	
Fistula.....						2
Gangrene.....	2				1	
Glanders.....						1
Hog cholera.....					1,145	
Immaturity.....		19				
Influenza.....					6	
Injuries.....	9	1	5		4	
Laminitis.....						1
Mammitis.....	1					
Metritis.....	2					
Moribund.....	3,091	2,865	7,833	60	21,950	241
Parturient paresis.....	1					
Pneumonia.....	12	1	16		58	
Pyrexia.....	10	4	6		879	
Purpura hemorrhagica.....						1
Rabies.....					1	
Rachitis.....					2	
Railroad sickness.....	2					
Septicemia.....	7	1	9		58	
Splenetic fever.....		1				
Tetanus.....	3					2
Tympanites.....	1					
Total.....	3,146	2,896	7,872	60	24,133	248

TABLE 9.—*Diseases and conditions for which condemnations were made of the entire carcass on post-mortem inspection, fiscal year 1930*

Cause of condemnation	Carcasses					
	Cattle	Calves	Sheep and lambs	Goats	Swine	Horses
Actinomycosis.....	388	21				
Anaplasmosis.....	90	2				
Anthrax.....		1			286	
Arsenic poisoning.....		1				
Arthritis and other bone diseases.....	140	130	350		5,930	2
Asphyxia.....	2	3	14		1,290	
Blackleg.....	12	7				
Caseous lymphadenitis.....			2,798	3		
Cellulitis.....					41	
Contamination.....	1	5	3		1,255	
Cysticercosis.....	131	20	223		98	
Dropsical diseases.....	37	1	17		69	
Emaciation.....	6,351	1,473	6,152	33	651	38
Gangrene.....	11	2	1			
Hog cholera.....					15,907	
Hydronephrosis.....		1			13	
Icterus.....	95	200	1,121	2	4,653	2
Immaturity.....		2,972	5			
Injuries, bruises, etc.....	2,649	580	835	2	1,655	32
Johne's disease.....	1					
Leukemia.....	1,265	43	14		274	
Lymphadenitis.....	1					
Melanosis.....	24	52	44		109	38
Moribund.....	31	31	12		106	
Necrobacillosis.....	23		2		3	
Necrosis.....	8				23	
Parasitic diseases.....	48		21		86	
Phlebitis.....		100				
Pneumonia, peritonitis, enteritis, pleurisy, etc.....	12,932	2,426	8,623	14	31,069	169
Pregnancy and recent parturition.....	26		9		10	1
Septicemia, pyemia, uremia, etc.....	5,790	832	2,227	4	22,963	17
Sexual odor.....	1		1	2	3,486	
Skin disease.....	1		3		212	
Splenic fever.....	52	52				
Strangles.....						2
Tetanus.....	1					
Tuberculosis.....	26,238	408	5		42,381	
Tumors and abscesses.....	3,186	82	430	2	2,852	152
Total.....	59,535	9,445	22,910	62	135,422	453

TABLE 10.—*Diseases and conditions for which condemnations were made of parts of carcasses on post-mortem inspection, fiscal year 1930*

Cause of condemnation	Parts of carcasses				
	Cattle	Calves	Sheep and lambs	Swine	Horses
Actinomycosis.....	86,177	1,941			
Bone diseases.....	12	7	66	86	
Caseous lymphadenitis.....			2		
Cellulitis.....				585	
Contamination.....	121	119	294	2,493	
Empyema.....	1				
Injuries, bruises, etc.....	944	114	111	30,356	
Melanosis.....	14	9		1	
Necrobacillosis.....	2		68	1	
Necrosis.....	309			4	
Parasitic diseases.....	415	8	3	1	
Rhinitis.....				1	
Skin diseases.....				1	
Tuberculosis.....	36,828	580	1	370,069	
Tumors and abscesses.....	8,527	3,229	203	422,871	2
Total.....	133,350	6,007	748	826,469	2

Table 11 shows the total condemnations on ante-mortem and post-mortem inspections.

TABLE 11.—Summary of condemnations, fiscal year 1930

Kind	Animals and carcasses	Parts of carcasses
Cattle.....	62,681	133,350
Calves.....	12,341	6,007
Sheep and lambs.....	30,782	748
Goats.....	122
Swine.....	159,560	826,469
Horses.....	701	2
Total.....	266,187	966,576

INSPECTION OF MEAT AND PRODUCTS

The inspection and supervision of meat and products prepared and processed are shown in Table 12, which, as noted, is a record only of inspection performed and not a statement of the actual quantity prepared.

TABLE 12.—Meat and meat food products prepared and processed under supervision fiscal year 1930

Product	Inspection ¹	Product	Inspection ¹
	<i>Pounds</i>		<i>Pounds</i>
Cured:		Lard oil.....	19,740,851
Beef.....	128,856,002	Lard stearin.....	2,643,840
Pork.....	2,981,863,768	Compound and other substitutes for lard.....	433,494,771
All other.....	1,432,077	Oleo stock and edible tallow.....	59,691,944
Sausage.....	783,628,996	Oleo oil.....	109,152,942
Canned:		Oleostearin.....	55,044,433
Beef.....	213,382,077	Oleomargarine.....	159,412,618
Pork.....	70,262,545	Miscellaneous.....	2,039,713,885
All other.....	6,226,953	Horse meat:	
Product passed for cooking:		Cured.....	12,024,741
Beef.....	2,680,856	Canned.....	13,222,099
Pork.....	7,029,823	Miscellaneous, including horse oil.....	507,325
All other.....	17,672		
Pork to be eaten uncooked.....	53,712,320	Total.....	8,960,934,516
Meat extract.....	48,373		
Lard.....	1,807,143,605		

¹ These totals of inspection pounds do not represent actual production, as the same product may have been inspected and recorded more than once in the process of manufacture.

NOTE.—The following quantities of meat and meat food products were condemned on reinspection and destroyed for food purposes on account of having become sour, tainted, unclean, rancid, or otherwise unwholesome: Beef, 1,960,791 pounds; pork, 6,321,133 pounds; mutton and lamb, 33,935 pounds; veal, 19,935 pounds; goat meat, 102 pounds; horse meat, 15,950 pounds; total, 8,351,846 pounds.

Market inspection, to facilitate interstate delivery of meats and products, was conducted in 26 cities.

MEAT AND PRODUCTS CERTIFIED FOR EXPORT

During the fiscal year a total of 90,837 official meat inspection certificates were issued to cover the exportation of the following products: Beef and beef products, 109,884,087 pounds; mutton and lamb, and mutton and lamb products, 2,913,954 pounds; pork and

pork products, 1,125,184,030 pounds; horse-meat products, 10,075,324 pounds; total, 1,248,057,395 pounds. There were also issued 4,066 certificates covering the exportation of 47,031,146 pounds of inedible animal products.

EXEMPTION FROM INSPECTION

The provisions of the meat inspection law requiring inspection usually do not apply to animals slaughtered by a farmer on the farm or to retail butchers and dealers supplying their customers. The retail butchers and dealers, however, in order to ship meat and meat food products in interstate or foreign commerce, are required to obtain certificates of exemption. The number of such certificates outstanding at the close of the fiscal year was 1,092. During the year 72 certificates were canceled on account of dealers' retiring from business or ceasing to make interstate shipments, change of address, insanitary conditions, violations of the meat inspection regulations, and handling inspected meat only.

During the year 45,411 shipments were made by retail butchers and dealers holding certificates of exemption as compared with 43,611 shipments during the fiscal year 1929. The shipments of the year covered products as shown in Table 13.

TABLE 13.—Shipments by retail butchers and dealers under certificates of exemption, fiscal year 1930

Kind of product	Carcasses	Pounds	Kind of product	Carcasses	Pounds
Cattle (361 quarters) -----	90	45, 301	Lard -----		14, 306
Calves -----	21, 231	1, 885, 494	Sausage -----		59, 536
Sheep and lambs -----	61	3, 060	Miscellaneous (scrapple, lard		
Swine -----	176	13, 174	substitutes, suet, head		
Beef, fresh -----		1, 813, 566	cheese, etc.) -----		27, 529
Veal, fresh -----		178, 671			
Mutton and lamb, fresh -----		419, 976	Total -----	21, 558	5, 139, 558
Pork, fresh -----		210, 309			
Cured meats -----		468, 636			

During the year 62,299 interstate shipments were made of meat and meat food products from animals slaughtered by farmers on farms, as compared with 63,732 shipments made during the fiscal year 1929. The products composing these shipments are shown in Table 14.

TABLE 14.—Shipments of farm-slaughtered meat and products, fiscal year 1930

Kind of product	Carcasses	Pounds	Kind of product	Carcasses	Pounds
Cattle (370 quarters) -----	92	35, 202	Cured meats -----		431, 743
Calves -----	59, 663	4, 947, 298	Lard -----		17, 409
Sheep and lambs -----	5, 073	162, 789	Sausage -----		151, 900
Swine -----	2, 196	92, 151	Miscellaneous (scrapple, suet,		
Beef, fresh -----		17, 205	head cheese, etc.) -----		29, 198
Veal, fresh -----		85, 927			
Mutton and lamb, fresh -----		8, 509	Total -----	67, 024	6, 101, 422
Pork, fresh -----		122, 091			

INSPECTION OF IMPORTED MEAT

Table 15 shows the inspection of imported meat and meat food products for the fiscal year.

TABLE 15.—*Imported meat and meat food products inspected and passed, fiscal year 1930*

Country of origin	Fresh and refrigerated meat		Canned and cured meat	Other meat products	Total weight
	Beef	Other classes			
	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>
Argentina.....			41,635,437	1,031,738	42,667,175
Australia.....	263,385	405,229	36	67,403	736,053
Brazil.....			7,616,485	30,242	7,646,727
Canada.....	9,345,183	5,509,091	12,300,438	4,802,078	31,956,790
New Zealand.....	12,104,662	874,759		113,671	13,093,092
Paraguay.....			6,971,212	48,820	7,020,032
Uruguay.....			28,730,622	402,367	29,132,989
Other countries.....	2,196,478	20,744	874,317	1,542,312	4,633,851
Total.....	23,909,708	6,809,823	98,128,547	8,038,631	136,886,709

Table 16 shows the quantities of foreign meat and products excluded from the country because of unsoundness, presence of prohibited preservative, or other failure to comply with the regulations.

TABLE 16.—*Imported meat and meat food products condemned and refused entry, fiscal year 1930*

Product	Con-demned	Refused entry
	<i>Pounds</i>	<i>Pounds</i>
Beef.....	106,445	46,845
Veal.....	120	40
Mutton and lamb.....		1,043
Pork.....	4,606	12,102
Total.....	111,171	60,030

IMPORTATION OF ANIMAL CASINGS

During the fiscal year foreign animal casings were admitted as follows: On certification, 20,523,000 pounds; on disinfection, 1,347,750 pounds; dried casings, 6,258 pounds; total 21,877,008 pounds. Casings amounting to 10,037 pounds offered for importation were rejected and removed from the United States.

INSPECTIONS FOR OTHER BRANCHES OF THE GOVERNMENT

By request of other branches of the Government reinspections of meat and meat food products were conducted, as shown in Table 17, to determine whether the articles remained wholesome and conformed to certain specifications.

TABLE 17.—*Inspections for other branches of the Government, fiscal year 1930*

Branch of Government	Passed	Rejected
	<i>Pounds</i>	<i>Pounds</i>
Navy Department.....	45, 676, 484	1, 093, 500
Veterans' Bureau.....	3, 376, 892	202, 983
Marine Corps.....	2, 509, 147	37, 206
Department of Justice (Federal penitentiaries).....	2, 489, 279	10, 166
War Department (Army Engineer Corps).....	1, 054, 054	35, 395
Department of Interior.....	769, 027	86
Public Health Service.....	401, 226	40, 896
Coast Guard.....	318, 791	6, 101
Department of Agriculture (Forest Service).....	44, 000	-----
Shipping Board.....	25, 285	-----
Alaska Engineering Commission.....	7, 039	-----
Total.....	56, 671, 224	1, 426, 333

MEAT-INSPECTION LABORATORIES

Analyses and examinations of meat and products were conducted in the meat-inspection laboratories situated in the several districts throughout the country.

The total number of products examined was 44,433. A total of 2,195 products were found to be not in accordance with the regulations. Included in these were meats and meat food products, edible fats and oils, cereals, spices, curing materials, colors, denaturing oils, water supplies, and miscellaneous articles.

About 1,700 samples of water were examined for evidence of pollution. All findings of pollution were followed by corrective action.

Further work on the denaturing of inedible fats led to a revision of rulings governing the denaturing and disposal of fats derived from condemned and inedible products whereby losses through condemnation are minimized and the disposal of condemned and inedible products facilitated.

By a method involving decharacterization with a harmless dye, livers condemned for a number of causes which collectively account for most of the separate condemnations of that organ, were made available for fish feed.

A large number of canned whole hams and canned chopped pork products were examined for composition and keeping quality.

A statistical study covering the incidence of ham souring at 13 typical establishments for a period of one year was completed and the results, which afforded further demonstration of the importance of correct temperatures in prevention, published.

LABELING MEAT AND MEAT FOOD PRODUCTS

During the year more than 18,000 labels and other markings for meat and products were approved for domestic establishments and 1,267 labels failed of approval on account of being misleading or deceptive.

The labeling of meat and products offered for importation was also carefully reviewed and appropriate correction required for honest and informative labeling. Foreign labels frequently are in several languages and couched in colloquial terms which add to the difficulties in censoring them.

The following are illustrations of submitted labels which required censoring in pursuance of law: Those alleging vitamin content with-

out specifying the vitamin actually present in substantial quantity; the proposed use of the word "cream" when whole cream to the exclusion of other fat or milk or its derivatives was not employed, and of the term "baked" as descriptive of articles exposed to a flame or otherwise treated to impart only to the outer surface the characteristics of a baked product; misleading illustrations depicting as constituents choice articles to the exclusion of inferior constituents which predominate; fantastic claims of flavor designed to mislead with respect to the actual derivation or character of the product; and terms constituting or encroaching upon grading symbols to imply erroneously that the products so marked are prepared from meats officially graded as superior quality.

PACKERS AND STOCKYARDS DIVISION

The work of the Packers and Stockyards Division was conducted during the year under the direction of A. W. Miller, chief. It involved, under the packers and stockyards act, supervision over the operations and practices of the packers, stockyard companies, market agencies, and dealers, and rates and charges for stockyard services. Under the livestock-quarantine laws and regulations, the work involved the inspection of all livestock received at public stockyards, the enforcement of the 28-hour law, and cooperation with the various States in the application of their laws and regulations designed to prevent the introduction of animal diseases.

FORMAL PROCEEDINGS UNDER THE PACKERS AND STOCKYARDS ACT

A summary of formal dockets, in which proceedings were instituted or cases decided during the fiscal year involving violations of the provisions of the act or the reasonableness of rates and charges for stockyard services, is given in the following statement:

FORMAL DOCKETS

Pending July 1, 1929.....	15
Instituted July 1, 1929, to June 30, 1930.....	24
Final action taken July 1, 1929, to June 30, 1930.....	25
Pending June 30, 1930.....	14

SUBJECT MATTER OF DOCKETS

Stockyard rates.....	6
Commission rates.....	10
Solvency.....	7
Trade practices.....	5
Bonds.....	8
Reparation.....	3

FORM OF ACTION

Cease and desist orders.....	4
Cease and desist order, suspension, and records prescribed to be kept.....	1
Order fixing rates.....	1
Orders of suspension.....	5
Dismissed.....	14

Of the 24 dockets instituted during the year, final action was taken on 12. The details of each of the formal dockets are given in a separate publication which may be had on request to the bureau.

CASES IN COURT PERTAINING TO THE PACKERS AND STOCKYARDS ACT

On February 24, 1930, the United States Supreme Court handed down a decision in the case of Tagg Bros. & Moorhead et al. *v.* the United States et al., which upheld the right of the Secretary of Agriculture to prescribe rates for buying and selling livestock at public stockyards. This decision marked the conclusion of litigation commonly known as the Omaha commission men's rate case, arising from an order by the Secretary of Agriculture on November 19, 1926, lowering the maximum commission charges for handling livestock at the Omaha stockyards. The United States Supreme Court also decided that the rates prescribed were reasonable as well as legal. The court's opinion dealt at length with the soundness of the evidence and testimony involved in the case, and is regarded as highly fundamental in the enforcement of the provisions of the act relating to rates and charges for services at public stockyards.

On June 16, 1930, arguments were presented before a Federal district court at Chicago, Ill., by counsel for the Government and the respondent in the case of the United States *v.* Roberts & Oake, packers, arising out of an order by the Secretary in Docket No. 160, requiring the respondent to furnish suitable bond to secure the performance of its obligations as a dealer incurred in the purchase of livestock at the Chicago stockyards. The case was pending at the close of the fiscal year.

STOCKYARDS

During the year two stockyards were posted as coming within the jurisdiction of the act, and none were released. At the close of the year the number of stockyards posted under the act was 73.

REGISTRATIONS

The status of the active registrants on June 30, 1930, is shown in Table 18.

TABLE 18.—*Number of commission men and other market agencies and dealers registered on June 30, 1930*

Class	Number of agencies handling—						Total
	All species	Cattle	Hogs	Sheep	Horses and mules	Other	
Market agencies:							
Commission men.....	759	5	2	13	15	29	823
Order buyers.....	127	71	29	11		26	264
Clearing agencies ¹							44
Miscellaneous ²							171
Total market agencies.....							1,302
Dealers:							
Buyers.....	790	579	232	129		331	2,061
Traders.....	101	545	161	36	14	39	896
Buyers and traders.....	51	37	13	14	1	22	138
Miscellaneous.....	32	15			4	13	64
Total dealers.....							3,159
Total registrants.....							4,461

¹ Does not include commission men and order buyers who render clearing services.

² Does not include commission men and order buyers who render miscellaneous services.

During the year 218 market agencies and 404 dealers were registered, and 239 market agencies and 614 dealers were placed on the inactive list.

RATES AND CHARGES

Very few changes were made in rates and charges for stockyard services during the year other than the usual changes in feed charges resulting from market fluctuations. All changes were scrutinized, and if a proposed increase did not seem warranted, the stockyard owner or market agency was requested to withdraw the tariff. If that was not done, or the reason for the increase was not satisfactorily explained, the bureau recommended formal proceedings for the purpose of determining the reasonableness of the rates.

During the year the detailed study of information relating to the origin and disposition of livestock at 10 of the leading markets was completed, as well as the valuations of the stockyard properties at South St. Joseph, Mo.; Denver, Colo.; and Kansas City, Mo. Hearings as to the reasonableness and lawfulness of the stockyard rates and charges at South St. Joseph, Mo., and Denver, Colo., were held and oral arguments were presented to the Secretary. These two cases were before him for decision on the record at the close of the year, and, in addition, a hearing on the stockyard rates and charges at Kansas City, Mo., was in progress.

Valuation and auditing work, with a view to holding hearings, was practically completed at National Stock Yards, Ill., and preliminary work has been begun at Omaha, Nebr.

During the year a hearing was held as to the rates and charges for stockyard services at Nashville, Tenn., as a result of which the Secretary issued an order fixing reasonable maximum rates and charges for services rendered by the Nashville Union Stockyards (Inc.).

Following the decision of the Supreme Court in the Omaha commission men's rate case the bureau promptly recommended the institution of proceedings at markets competitive with Omaha, for the purpose of determining the reasonableness of commission rates. Thereupon the Secretary instituted an inquiry at Sioux City, Iowa, and a hearing was held in May. Arrangements were being made at the close of the year for the presentation of oral arguments to the Secretary with a view to reaching an early decision. An inquiry was also instituted with reference to the reasonableness of commission rates at Kansas City, Mo., and a hearing set to begin in the fall of 1930. This program contemplates a series of hearings to be held at several of the leading markets for the purpose of determining the reasonableness of commission rates.

BRAND INSPECTION

The authority given the Secretary to authorize the charging and collection of a brand-inspection fee, carried in a provision in the agricultural appropriation act for the fiscal year ended June 30, 1930, was continued in the appropriation act for the fiscal year ending June 30, 1931. This automatically extended and continued in effect the authorizations heretofore granted by the Secretary to a number of livestock organizations which are carrying on brand-

inspection work at a number of the larger stockyards. Several petitions were received from State livestock associations asking that the authorizations be amended to permit the collection of fees for the inspection of cattle whether branded or not, but, since the provision of the amendment clearly limits the collection of a fee to the service performed in inspecting brands appearing on livestock, these requests could not be granted.

TRADE PRACTICES

Supervisors continued their activities in assisting in the revision of tariffs and regulations of market agencies and stockyard companies, and made numerous investigations and reports on general marketing conditions. A large number of complaints, both formal and informal, were received by the bureau and carefully investigated, by either supervisors or special investigators in the field. In a great many instances the facts did not disclose any violations of the act. In some, certain unsatisfactory conditions which were found were corrected informally and, in others, formal notices of inquiry were issued.

A number of trade-practice audits were made during the year at several markets covering approximately 29 market agencies and dealers, as a result of which a number of unsatisfactory conditions and practices were corrected, usually by means of informal action, due to the fact that they were not, in most instances, of a sufficiently serious character to warrant formal proceedings.

Several complaints received from so-called independent cream buyers and butter manufacturers, regarding alleged price discrimination and monopoly on the part of packers engaged in the purchase of cream and butterfat, were carefully investigated, but in no case were sufficient facts found to warrant the issuance of a formal notice of inquiry.

A trade-practice conference for the meat-packing and wholesale meat industry was held at Chicago, Ill., on October 22, 1929, at the invitation of the Secretary of Agriculture. At the direction of the Secretary, the chief of the bureau represented the department and presided at the request of those present. Over 1,200 invitations were sent out to packers, and it was estimated that at least 95 per cent of the industry, calculated on the basis of gross sales, was present or represented at the conference. At this conference resolutions were unanimously adopted, which have been designated as the code of trade practices of the American meat-packing industry. The purpose of the code is the elimination of unfair and uneconomical practices among packers and wholesalers, with respect to classes of products of which the American packing industry is the predominant manufacturer, and with respect to livestock of which it is the chief purchaser. This code consists of four main resolutions, two of which deal directly with a number of practices and customs which the industry declares to be unfair, unethical, or uneconomical. On November 11, 1929, the Secretary issued a public statement, expressing approval of these resolutions and urging strict compliance with them. He stated that the department would take such action as the facts and law warranted with respect to alleged violations of these reso-

lutions by packers subject to the provisions of the packers and stockyards act. He also pointed out that a somewhat similar plan had been followed with excellent results by the Federal Trade Commission in dealing with other industries, and that the results accomplished by the packing industry, working in harmony with the department in building up a high code of ethics, should be equally satisfactory. A few complaints were made to the bureau regarding alleged violations of these resolutions up to the close of the year, some of which, on investigation, were not substantiated, while others, of minor nature, were corrected informally.

BONDS

Market agencies and dealers generally have complied with the bond requirements. In a few instances where bonds were not furnished and informal action failed, formal proceedings were instituted to effect compliance with the bond regulations.

SCALES AND WEIGHING

During the year bureau weight supervisors, in addition to making inspections and conducting tests of scales, supervised several new installations. Arrangements were perfected at a group of stockyards for a program of quarterly scale tests to be made when the weight supervisor was present. Efforts were continued to have all posted stockyards where conditions justified obtain and use the type of scale-testing equipment recommended by the bureau. The superiority and economy of scales installed in accordance with modern methods were demonstrated in several instances where it was found that less time and expense were required for testing and the scales remained accurate to a degree not usually experienced with older designs.

AUDITS AND ACCOUNTS

During the year financial audits were made by bureau accountants of the books and records of approximately 40 stockyard companies and 22 commission firms at several markets, setting forth the results of the operations and the financial condition of the companies and agencies. Several of these audits were made for the purpose of determining the solvency of market agencies and resulted, in some cases, in the issuance of inquiries and the suspension of registrations because of insolvency, as shown in the report of dockets. Trade-practice audits were made by bureau accountants of approximately 29 market agencies and dealers located at various markets. Detailed audits of four stockyard companies, preparatory to holding hearings in connection with the reasonableness of rates and charges for stockyard services, were completed during the year. In addition, the books and records of approximately 120 market agencies were examined at two markets for the purpose of holding hearings in connection with the reasonableness of rates and charges for buying and selling livestock on commission.

As was the case last year, annual reports were received from all classes of agencies and persons subject to the provisions of the act. The number of reports received from packers this year was greater

than any since the act became effective, due, in part, to a more intensive investigation and survey of the operations of packers throughout the country. Information compiled from the reports received from packers, stockyard companies, and market agencies is shown in Tables 19 to 26, inclusive. The data compiled from traders' reports are shown in Table 26, and relate solely to those persons who were engaged strictly in a trading or speculative business. The various reports received cover business during the calendar year, with a few exceptions which are on the basis of the fiscal year. The tables afford a perspective of the volume and character of the business conducted by persons subject to the provisions of the act.

TABLE 19.—*Financial results of operations during 1929 for 832 packers subject to the packers and stockyards act, grouped according to federally and nonfederally inspected slaughtering and nonslaughtering concerns*

Group	Num- ber of con- cerns	Average net worth ¹	Net sales	Net gain
Federally inspected slaughterers.....	215	\$801, 858, 079	\$3, 559, 116, 692	\$35, 996, 445
Nonfederally inspected slaughterers.....	372	53, 557, 331	289, 002, 009	3, 909, 686
Nonslaughterers ²	245	164, 564, 688	447, 229, 982	25, 835, 501
Total.....	832	1, 019, 980, 098	4, 295, 348, 683	65, 741, 632

¹ These figures represent the numerical average of the total net worth of reporting concerns at the beginning and end of their fiscal years.

² This group includes concerns which also handle commodities other than meat food products.

In addition to the complete reports from 832 packing concerns, financial details, lacking in some respects, were received from 125 other packers for the year 1929.

TABLE 20.—*Comparison of the operations of packers subject to the packers and stockyards act, 1925-1929*

Item	1925 514 concerns	1926 580 concerns	1927 611 concerns	1928 680 concerns	1929 832 concerns
Average net worth ¹	\$940, 268, 445	\$989, 916, 117	\$970, 772, 548	\$983, 705, 930	\$1, 019, 980, 098
Total income.....	3, 816, 528, 294	3, 758, 972, 700	3, 877, 621, 354	4, 110, 095, 060	4, 308, 814, 715
Total expenses.....	3, 751, 970, 047	3, 699, 943, 922	3, 839, 325, 046	4, 039, 890, 813	4, 243, 073, 083
Net gain.....	64, 558, 247	59, 028, 778	38, 296, 308	70, 204, 247	65, 741, 632
Per cent of gain to net worth.....	6. 87	5. 96	3. 94	7. 14	6. 45

¹ These figures represent the average of the total net worth of all reporting concerns at the beginning and end of their fiscal years.

STOCKYARDS POSTED UNDER THE PACKERS AND STOCKYARDS ACT

TABLE 21.—*Summary of consolidated balance sheets of 69 posted stockyards at close of year 1929*

Assets	Amount	Liabilities	Amount
Current.....	\$13, 060, 593	Current.....	\$3, 029, 287
Fixed.....	136, 609, 987	Other.....	37, 219, 218
Other.....	11, 683, 273	Capital and surplus.....	121, 105, 348
Total.....	161, 353, 853	Total.....	161, 353, 853

TABLE 22.—*Summary of consolidated profit and loss statements of 69 posted stockyards for year 1929*¹

Income:	
Yardage.....	\$11,710,730
Feed sales.....	12,326,993
Loading and unloading.....	1,622,486
Rent.....	2,120,695
Miscellaneous operations.....	2,376,485
Gross operating income.....	30,157,389
Expenses:	
Salaries and wages.....	6,678,692
Cost of sales—feed.....	6,688,326
Depreciation.....	1,959,591
Taxes (excluding Federal income tax).....	462,974
Miscellaneous operating expenses.....	6,717,854
Total operating expenses.....	22,507,437
Net operating profit.....	7,649,952
Other income.....	1,470,972
	9,120,924
Other deductions.....	2,005,935
Net profit.....	7,114,989

¹ Reports from two yards waived and two yards not posted until too late for tabulation.

TABLE 23.—*Summary of reports from stockyard companies subject to the packers and stockyards act, 1925-1929*

Item	1925 62 concerns	1926 65 concerns	1927 69 concerns	1928 67 concerns	1929 69 concerns
Total average net worth.....	\$115,888,752	\$116,327,131	\$118,071,659	\$119,274,997	\$120,360,158
Gross income.....	37,406,167	36,086,366	35,108,893	31,355,620	30,157,389
Net gain.....	6,672,983	6,561,847	6,829,009	7,533,519	7,114,989
Per cent of gain to net worth.....	5.76	5.64	5.78	6.32	5.91

LIVESTOCK COMMISSION AGENCIES

TABLE 24.—*Number and class of market agencies reporting, 1929*

Old-line agencies.....	688
Cooperative agencies.....	29
Horse and mule agencies.....	15
Total.....	732

TABLE 25.—*Summary of consolidated operating statements of livestock commission agencies*

Item	1927 729 agencies	1928 752 agencies	1929 732 agencies
Total commissions earned.....	\$23,017,604	\$23,331,401	\$22,025,768
Operating expenses (exclusive of owners' salaries).....	16,186,814	16,223,981	15,720,777
Net operating profit.....	6,830,790	7,107,420	6,304,991
Other income.....	1,267,499	1,126,666	1,066,828
Other expenses.....	35,351	38,589	41,301
Return to owners.....	8,062,938	8,195,497	7,330,518

TABLE 26.—*Summary of consolidated profit and loss statements of 883 traders on 42 markets for 1929¹*

Item	Dockage :	Animals handled	Weight	Amount
Cattle:				
643 traders on 36 markets—	<i>Pounds</i>	<i>Number</i>	<i>Pounds</i>	<i>Dollars</i>
Selling data.....		3,858,355	1,894,851,111	233,976,387
Cost data.....		3,858,650	1,888,628,795	226,394,423
Sheep:				
70 traders on 23 markets—				
Selling data.....		1,546,081	111,819,483	13,840,994
Cost data.....		1,547,575	112,015,341	13,255,688
Horses and mules:				
13 traders on 4 markets—				
Selling data.....		30,068		3,874,333
Cost data.....		30,068		3,408,684
Hogs:				
201 traders on 33 markets—				
Selling data.....	3,716,940	3,848,109	823,581,235	84,243,292
Cost data.....	4,158,560	3,849,729	817,613,674	82,423,464
All species:				
883 traders on 42 markets—				
Selling price.....				335,935,006
Cost price.....				325,482,259
Gross trading profit.....				10,452,747
Clearance commissions received.....				22,043
Other income.....				233,495
Total earnings.....				10,708,285
Expenses:				
Salaries and wages (other than owners').....				1,675,986
Clearance commissions paid.....				673,877
Feed.....				2,536,104
Yardage.....				341,972
Other expenses.....				1,752,548
Total.....				6,980,487
Return to owners.....				3,727,798

¹ Does not include traders who were engaged also in order-buying business. Some of the traders handled more than 1 species.

² Represents deduction in weight at time of sale because of quality or condition of the animal. This practice applies only to hogs.

CONTROL OF INTERSTATE TRANSPORTATION OF LIVESTOCK

Supervision over the interstate transportation of livestock in order to prevent the spread of animal diseases was maintained as in previous years. In connection with this work bureau employees inspected 18,825,165 cattle, of which 10,540 were dipped under supervision in order that they might continue in interstate commerce. There were also inspected for communicable diseases 26,773,315 sheep, and 652,649 of these were dipped under bureau supervision to comply with regulations of the department and the various States to which they were destined. The number of swine inspected was 41,040,770, and 388,676 were immunized and disinfected against hog cholera under supervision in order that they might be distributed to country points for feeding and breeding purposes.

Further efforts were made to reduce losses among stocker and feeder cattle on account of hemorrhagic septicemia. Divisions of public stockyards in which that class of cattle is handled and of railroad stockyards regularly used in the feeding, watering, and resting of livestock were again cleaned and disinfected under bureau supervision. The bureau continued its cooperation with various transportation and marketing organizations in considering measures

and in distributing information designed to assist livestock raisers in preventing the development of the disease.

There were received at bureau stations during the year 15,474 cars carrying animals affected with communicable diseases. Under department regulations or on request of Canadian Government officials, State officials, and transportation companies, 27,564 cars were cleaned and disinfected under bureau supervision.

Experienced veterinary inspectors at the various public stockyards continued to give particular attention to the inspection of all ruminants and swine for foot-and-mouth disease.

ENFORCEMENT OF TRANSPORTATION AND QUARANTINE LAWS

Administration of the 28-hour law which limits the time of confinement of animals in cars without feed, water, and rest was continued as in previous years. Apparent violations to the number of 264 were reported to the solicitor of the department for presentation to the Attorney General. Penalties amounting to \$29,075 were imposed in cases decided in favor of the Government. The evidence was collected and the reports prepared largely by employees stationed at public stockyards as a part of their regular duties, there being only four employees who devote their entire time to that work. Further improvements in facilities for the feeding, watering, and resting of livestock in transit were effected at a few points. There were also reported for prosecution during the year 66 cases of alleged violations of the quarantine laws and regulations and fines to the amount of \$4,025 were imposed in cases decided in favor of the Government.

PATHOLOGICAL DIVISION

Under the direction of John S. Buckley, chief, the Pathological Division has followed its usual line of scientific investigation of the diseases of domestic animals and birds, the poisoning of livestock by plants, and the examination of viruses, serums, and other biological products used in the treatment or prevention of diseases of domestic animals.

DIAGNOSIS AND CONTROL OF DISEASES

GLANDERS

Cooperative work for the control and eradication of glanders in the various States was continued. The complement-fixation test was applied to 277 samples of blood serum from animals suspected of being affected with or exposed to the disease, 18 of which gave positive reactions.

DOURINE

In the course of the campaign for the control and eradication of dourine, 9,847 samples of blood serum from horses in districts where dourine is present or suspected were subjected to the complement-fixation test, and 252, or approximately 2.6 per cent, gave positive reactions.

TESTING ANIMALS FOR IMPORT

Blood-serum samples from 36 horses, donkeys, and other animals offered for import were subjected to the complement-fixation test for glanders and trypanosomiasis before the animals were admitted.

AUTOPSIES ON ANIMALS FROM THE NATIONAL ZOOLOGICAL PARK

Twenty-two animals from the National Zoological Park were autopsied in an effort to determine the cause of death, which was established in 19 cases.

POULTRY DISEASES

During the year 924 poultry specimens were received for examination. Examination revealed the usual diseases common to poultry, including pullorum disease in baby chicks and adult birds, coccidiosis, roup, chicken pox (diphtheria), infectious bronchitis, blackhead disease in turkeys, fowl cholera, fowl typhoid, tuberculosis, salpingitis, leukemia, and other minor conditions.

Some investigational work was done with infectious bronchitis, in an effort to determine the cause and nature of this infection.

EXAMINATION OF SPECIMENS FROM MEAT-INSPECTION AND MISCELLANEOUS SOURCES

During the year 241 specimens were received for diagnosis, from various meat-inspection centers, and 602 specimens from various species of animals from miscellaneous sources were received. These specimens are not included in the number of specimens mentioned elsewhere in this report. In this connection a total of 3,077 letters requiring attention were also received during the year.

RABIES

One hundred and thirty-six suspected cases of rabies were received and subjected to laboratory examination. Of these 111 were from dogs, 64 of which were positive. Of 19 cats examined, 8 were positive; of 3 horses, 2 were positive and 1 negative, while the examination of 3 specimens from cows resulted in 1 positive finding and 2 negative. Specimens from 1 sheep, 1 rat, and 1 squirrel were examined with negative results.

FOCAL NECROSIS OF SWINE VERTEBRAE CAUSED BY BACTERIUM ABORTUS

Bureau inspectors sometimes encounter necrotic areas of the bodies of one or more of the vertebrae of hogs slaughtered at various establishments. The lesions show a rather close resemblance to those of tuberculosis and appear to be confined to the bones. Specimens of cervical and lumbar vertebrae presenting this type of lesions were received in the latter part of April of this year from T. Castor, of Philadelphia. Bacteriological study of this material resulted in determining *Bacterium abortus* (sometimes called *Brucella abortus*) (porcine type) as the causative agent. This is the first instance noted of focal necrosis of the bones due to the abortion organism. Owing

to the high virulence of the swine bacillus and its pathogenicity for man, these bone lesions have a special significance in meat inspection work.

RESEARCH ON DISEASES

PERIODIC OPHTHALMIA OF HORSES AND MULES

Investigation of periodic ophthalmia was begun in July, 1929, and continued through the fiscal year. A number of affected animals from near-by farms became available for study purposes. Some of these appeared to be especially good subjects for transmission experiments and were acquired through purchase or gift.

Bacteriological and serological examinations were made of each diseased animal, looking to the detection of a cultivatable causative microorganism, should such be present. Practically all the cultures made from the aqueous humor after withdrawal from the eye with sterile syringe and needle remained sterile.

In view of the recent investigations of this disease by E. C. Rosenow, of the Mayo Foundation, and his published findings which conclude a diplococcus and a pigment-producing bacterium to be the causative agents of periodic ophthalmia, a special search was made throughout the examinations for these types of microorganisms.

In no instance was the so-designated flavo-bacterium ophthalmia encountered in horses or mules affected with acute or subacute periodic ophthalmia. In three instances out of five, however, an organism indistinguishable from the flavo-bacterium ophthalmia was recovered from the lachrymal sacs of healthy horses at the Experiment Station, Bethesda, Md. So far as can be determined no animals have ever developed periodic ophthalmia at that place.

Attempts were made to produce periodic ophthalmia in horses by inoculations with cultures of the flavo-bacterium ophthalmia obtained from Doctor Rosenow. Administration of these cultures by feeding, intravenous, intraocular, and intracerebral inoculations were uniformly unsuccessful in producing periodic ophthalmia. Those horses that received intravenous injections of the culture frequently developed abscesses in the lungs. Inoculation of the cultures into the interior chamber of the eye produced a suppurating panophthalmitis followed by a sloughing of the eyeball. The opposite eyes always remained normal during the time of observation, which extended over a period of 12 to 18 months. Horses and mules that were maintained on diets deficient in the antiophthalmic vitamin did not develop periodic ophthalmia.

After failure to detect a cultivatable microorganism in the interior of the eyes of horses affected with periodic ophthalmia, attempts were made to reproduce the disease by transferring the aqueous humor of affected eyes into the anterior chamber of the eyes of normal horses, which in one case resulted in the development of typical symptoms of periodic ophthalmia in a mule eight months after such transfer of eye fluids. The investigations are being continued.

VACCINATION OF DOGS AGAINST RABIES

Experimental work on the prophylactic vaccination of dogs against rabies was continued during the year. Additional potency tests on dogs were made with vaccines rendered avirulent by the use of

chloroform. While the results of these tests were not conclusive, owing to the small percentage of control dogs which developed rabies, some further support to the previous evidence that chloroform-treated vaccines are capable of producing a high degree of immunity in dogs was obtained.

CHRONIC PROGRESSIVE PNEUMONIA OF SHEEP

Pathological and bacteriological studies of the so-called "lunger" sheep disease of Montana were resumed during the year. A number of experimental sheep were inoculated with lung material and with different microorganisms obtained from affected Montana sheep. The results of these experiments obtained to date do not justify any definite conclusions as to the cause of the chronic pneumonia.

STUDIES OF NASAL GRANULOMA OF CATTLE

During the year a very peculiar and interesting nasal affection was found among the dairy cattle at the Jeanerette Livestock Experiment Farm, Jeanerette, La. So far as is known at the present time this disease has not been observed before among the cattle of this country. About 20 per cent of a herd of approximately 60 head of cattle showed evidence of the disease.

The lesions are confined to the nasal passages and consist of a thickening, or congestion and edema, of the mucous membranes with the formation of numerous small, grayish, or ricelike nodules, thickly studding the affected areas. The lesions usually extend only 3 or 4 inches up the nasal cavity from the outer opening. Difficult breathing results from the thickened mucosa in the more advanced cases. No other cases have been found outside this particular herd.

A number of organisms including several fungi were obtained in cultures from the nodular lesion. Animal inoculations with a number of these have thus far given negative results. Ten or more cattle were inoculated in the nasal mucosa with the nodular material, but nothing of a definite nature resulted.

EXPERIMENTAL STUDIES OF PSEUDOLEUKEMIA OF CATTLE

A limited study of pseudoleukemia has been undertaken consisting chiefly of histological examinations and guinea-pig inoculations. A considerable number of cases have been received for study, and this work is still under way.

HISTOLOGICAL STUDIES OF BOVINE MAMMARY GLANDS

Histological studies of udders of dairy cows as related to milk production are being continued in cooperation with the Bureau of Dairy Industry.

INFECTIOUS ANEMIA OR SWAMP FEVER OF HORSES AND MULES

Experimental animals inoculated with blood obtained from animals in the Mississippi Delta, suspected of being affected with swamp fever, are being held for observation and study at the Experiment Station at Bethesda, Md.

Nothing of a definite nature has developed in these animals, but investigational work on the disease is being continued.

ANAPLASMOSIS

Field observations in Florida during the year showed a marked decrease in the number of cases of anaplasmosis, compared with the previous year. The sodium-cacodylate treatment was continued, and of 79 cases treated only 6 died. In one large herd in which the infection has been particularly serious for several years, there were no cases during the year covered by this report.

EQUINE TUBERCULOSIS

An 8-year-old mare which had been suffering from a pulmonary affection reacted to the tuberculin test and at autopsy showed extensive lesions in lungs and mesenteric lymph glands with slighter lesions in spleen, pleura, and peritoneum. Four years previously the entire herd of cattle on the farm was condemned on account of tuberculosis. The herd which replaced the diseased one passed a clean test at the time the mare was tested. Bacteriological examination of specimens from the mare revealed the presence of a bovine type of tubercle bacillus of low virulence.

CANCER OF THE EYE IN CATTLE

Cancer of the eye in cattle is encountered rather frequently at some of the larger slaughtering establishments in the course of the work of the meat inspection division. An investigation of the disease is now being conducted to ascertain the relation of this cancer of the eye of cattle to other forms of surface cancer, and to study the mode of infection and the transmissibility of the disease.

TESTING BIOLOGICAL PRODUCTS

Coöperating with the Division of Virus-Serum Control in the enforcement of the virus-serum-toxin act, the Pathological Division was called on to examine biological products and cultures prepared under United States veterinary licenses.

During the year 91 representative samples of serums, vaccines, bacterins, and antitoxins were examined for purity, potency, and safety. Of these 68 were approved and 23 were disapproved. In the same period 296 cultures were tested, of which 70 were found to be unsatisfactory for their intended purpose.

INVESTIGATION OF STOCK-POISONING PLANTS

Investigations of plants suspected to be poisonous to livestock were continued during the year on the same plan as heretofore. Most of the experimental work was carried on at the Salina Experiment Station, near Salina, Utah. This station was open from June 1 until September 30, and during that time most of the office work as well as the experimental work was conducted at the station. Feeding experiments were undertaken with 25 plants suspected of causing losses to livestock.

THE TEXAS LOCO INVESTIGATION

The results of the preliminary investigation of the loco situation in western Texas which was made in the preceding fiscal year have been summarized with the aid of the systematic botanists of the Bureau of Plant Industry. This work is being continued by field feeding experiments in Texas through a cooperative agreement between the bureau and the Texas Agricultural and Mechanical College.

FIELD INVESTIGATIONS

A trip was made to Klamath Falls to confer with E. R. Kalmbach, of the Bureau of Biological Survey, in regard to the deaths of ducks, and later to the Bear River marshes to investigate the same subject. The general result of these two trips indicated that the deaths of the ducks were probably not caused by eating any form of vegetation.

Two trips were made to the game preserves of Pennsylvania to investigate the cause of the deaths of deer. These deer had evidently been grazing largely on mountain laurel and rhododendron, and it had been thought possible that these plants were the cause of the fatalities. The results of the investigation, and especially the results of the experimental feeding carried on by Doctor Forbes, of the State College of Pennsylvania, seemed to show rather conclusively that the deaths were not caused by eating mountain laurel or rhododendron.

A short trip was also made into the Sawtooth National Forest, Idaho, to investigate the losses of cattle. In this case there seemed to be no doubt that the losses were due to larkspur.

CONTRIBUTIONS TO POISONOUS-PLANT LITERATURE

During the year the results of investigation on the following subjects were presented for publication: The toxic effect of St. Johnswort, *Hypericum perforatum*, on cattle and sheep; mountain-laurel, *Kalmia latifolia*, and sheep laurel, *K. angustifolia*, as stock-poisoning plants; black laurel, *Leucothoe davisiae*, and Laborador tea, *Ledum glandulosum*, as stock-poisoning plants.

Besides the foregoing a number of short popular articles were prepared for technical and livestock journals.

TOXICOLOGICAL INVESTIGATIONS

TREMBLES

The study of trembles (milk sickness) has been continued. It was demonstrated that the toxic constituent of rayless goldenrod (*Aplopappus heterophyllus*) is tremetol, the same substance that causes the toxicity of white snakeroot. The results were published in a paper in the Journal of Agricultural Research, April 1, 1930. Tremetol was also isolated from *A. fruticosus*, which also causes trembles. A chemical description of tremetol was published in the December, 1929, issue of the Journal of the American Chemical Society. Study of the chemical constitution of tremetol to determine the peculiar arrangement of the atoms in the molecule on which depends its characteristic toxicity was continued.

LUPINES

Study of this genus was continued. Alkaloids were isolated from *Lupinus palmeri*, *L. parviflorus*, *L. foliosus*, *L. argenteus*, *L. cruckshanksii*, and *L. laxiflorus*, var. *silvicola*. These alkaloids are being studied chemically and pharmacologically.

ASCLEPIAS

Study of the poisonous members of this genus has been continued. Much time has been spent on *A. gallioides* in separating and purifying the active constituents. A paper describing the toxic constituent of *A. eriocarpus* was published in the American Journal of Pharmacy for December, 1929.

DAUBENTONIA

The active principle of this plant has been isolated in an impure condition and efforts are being made to purify it sufficiently to permit exact chemical description of it.

BARLEY

A study of the abnormal constituents present in barley infested with certain molds was continued. Considerable progress was made but final results have not yet been obtained.

CHLORATE POISONING

The extensive use of sodium chlorate and mixtures containing this drug as weed killers prompted a study of the toxicity of the chlorates to domestic animals. It was found that rather large doses of sodium chlorate are poisonous to livestock and warnings were issued in accordance with these findings. This study is being continued.

BRANCH LABORATORIES

BETHESDA, MD.

The experiments in incubator transmission of pullorum disease were completed. An analysis of the complete figures was reported December 6, 1929, before the National Poultry Congress, Chicago, and are incorporated in a paper presented before the World's Poultry Congress in London, July, 1930.

As a result of cooperation with the Biochemic Division in the study of whole-blood rapid agglutination tests for pullorum disease, a new sterile antigen has been developed. Field studies of this antigen are now in progress.

A number of commercial flocks have been tested by various methods, principally the tube-agglutination test and the plate-agglutination test (whole blood), and the reactions were compared. It was found that a correlation of 87.6 per cent existed between these two tests.

About 2,500 young fowls were tested for the United States Animal Husbandry Experiment Farm, Beltsville, Md., in the control of pullorum disease. Repeated tests have been made at frequent intervals on a flock of chickens reared at the Bethesda station.

CHICAGO

The branch pathological laboratory at Chicago, Ill., has conducted investigations of diseases in meat food animals, similar to those conducted in previous years. These investigations consist principally in making diagnosis of diseased conditions in animals slaughtered in establishments operating under the Federal meat inspection.

In addition, several hundred cold-storage chickens were examined for the Federal Food and Drug Administration laboratory at Chicago, Ill. Most of the chickens were culls, and a very high percentage of tuberculosis was found in them. A number of other diseases, such as leukemia, enteritis, peritonitis, and pyemia, were encountered, and some of the chickens were found to be in various stages of decomposition.

Cooperation and assistance were extended to the laboratories of the Chicago health department and the Municipal Tuberculosis Sanitarium, as well as medical colleges.

As in former years, a number of museum specimens of interesting pathological changes were prepared for exhibition purposes, and forwarded to the department's office of exhibits, at Washington, D. C.

DENVER

During the year, 1,258 specimens were received at the Denver bacteriological laboratory for examination. More than 50 per cent of these specimens were from poultry.

The major project during the year was the investigation of anaplasmosis in cooperation with the Oklahoma Agricultural and Mechanical College. Many field inspection trips included autopsies, confirming diagnoses, and consultations with practicing veterinarians. The collection of ticks, flies, and other insects for contact experiments was continued.

Miscellaneous work included a circular prepared for publication and several addresses given at State veterinary meetings.

OMAHA

Specimens received for examination at this laboratory during the year numbered 479. Of these, 177 were specimens from cattle reacting to tuberculin but which showed no lesions on post-mortem examination. The remaining 302 specimens were from various species of animals and presented a variety of pathological conditions.

TICK ERADICATION DIVISION

The work of freeing the South from the cattle tick which transmits splenic, southern, or tick fever in cattle was continued under the direction of R. A. Ramsay, chief, in cooperation with cattle owners and State and county officials in the infested Southern States.

The field activities in this project are directed from eight field stations. At the close of the fiscal year 338 veterinarians and other bureau employees were attached to these stations and working in cooperation with 493 State and 75 county employees. Under the supervision of these cooperating forces 16,136,527 inspections or dippings of cattle and 1,588,651 inspections or dippings of horses and mules were conducted and more than 14,000 cattle dipping vats were used in the official dippings.

RESULTS FOLLOWING THE YEAR'S ACTIVITIES

The following areas were released from Federal quarantine as a result of tick-eradication activities: One county in Alabama, 4 counties in Florida, 6 counties in Mississippi, and 4 counties in Texas. The release of territory in Alabama places all of that State above the tick-quarantine line, thus making it the tenth of the original 15 tick-infested States to reach that goal.

In addition to the area released during the fiscal year, such satisfactory progress was made in eradicating the tick from 17 counties remaining in quarantine in the State of Mississippi, that an order releasing all that territory from Federal quarantine was approved by the Secretary of Agriculture on June 11, 1930, and the release of the whole State became effective July 1, 1930.

Owing to failure to protect Jefferson Davis Parish, La., which was released from quarantine in 1917, from reinfestation, it was found necessary to requarantine that parish during the year.

The close of this fiscal year finds the Federal quarantine for cattle-tick infestation in the United States confined to parts of four States, viz, Texas, Florida, Arkansas, and Louisiana. In Texas and Florida the war on the tick is being vigorously prosecuted and good headway is being made each year in eliminating the pest and adding to the tick-free territory. In Arkansas the work for the last two years has been greatly retarded by insufficient funds, although the State has an effective tick-eradication law. The work is well supported by public sentiment and the State may be expected to clean up rapidly just as soon as an adequate State appropriation is available.

In Louisiana, owing to the lack of an effective tick-eradication law, the work has been practically at a standstill or has lost ground during the last five years. The Louisiana Legislature this year enacted a new tick-eradication law which, if supported by an adequate appropriation, should prove to be satisfactory and result in the early renewal of active tick eradication in that State.

Table 27 shows the progress made in tick eradication since its beginning, in 1906, and gives the status of the work at the close of the fiscal year 1930.

TABLE 27.—*Tick-eradication results July 1, 1906, to June 30, 1930*

State	Counties quaran- tined on—		Counties released to June 30, 1930	Released counties tick-free on Nov. 1—			
	July 1, 1906	June 30, 1930		1926	1927	1928	1929
Alabama.....	67	0	67	49	57	59	63
Arkansas.....	75	20	55	41	44	45	45
California.....	15	0	15	15	15	15	15
Florida.....	67	37	30	12	14	22	30
Georgia.....	158	0	158	151	153	154	155
Kentucky.....	2	0	2	2	2	2	2
Louisiana.....	64	42	22	11	4	8	3
Mississippi.....	82	17	65	47	46	45	55
Missouri.....	4	0	4	4	4	4	4
North Carolina.....	73	0	73	73	71	73	73
Oklahoma.....	61	0	61	55	54	54	60
South Carolina.....	46	0	46	40	44	46	46
Tennessee.....	42	0	42	42	42	42	42
Texas.....	198	68	130	72	77	79	94
Virginia.....	31	0	31	27	26	29	30
Total.....	985	184	801	641	653	677	717

MOVEMENTS FROM QUARANTINED AREAS

In the enforcement of department regulations governing the interstate movement of cattle and horses from the areas quarantined for splenic, southern, or tick fever, 149,760 cattle were inspected, or dipped and inspected, for which 2,668 certificates were issued authorizing their interstate movement as noninfectious. Horses and mules to the number of 7,160 were also inspected in the quarantined areas and 718 certificates issued authorizing their movement from the area.

MOTION PICTURES HELP TICK ERADICATION

The use of motion pictures in demonstrating the methods used in accomplishing tick eradication and the benefits to be derived from this work has continued to prove its value in preparing for the active eradication campaign and has been adopted as a routine preliminary step in this work. This year the two portable motion-picture outfits gave 510 exhibitions in the States of Texas, Florida, and Mississippi, with a total of 63,018 persons in attendance.

TUBERCULOSIS ERADICATION DIVISION

The work of tuberculosis eradication in cooperation with the various States, counties, and livestock owners made substantial progress during the year. This work on the part of the bureau was directed by A. E. Wight, chief of the Tuberculosis Eradication Division.

The year's activities consisted largely in the tuberculin testing of cattle under the area plan. Altogether 12,845,871 cattle were tested, or about 1,160,000 more than in any preceding year. The percentage of reactors dropped from 1.8 for the fiscal year 1929 to 1.7. This decrease indicates continued progress in eradicating the disease.

The bureau's force engaged in tuberculosis eradication averaged 199 veterinarians, who were under the supervision of inspectors in charge of 44 field stations. The respective States had under the jurisdiction of their livestock officials an average of 417 veterinarians, a small number of whom were employed by municipalities. The respective counties cooperating with the officials of the States and the bureau employed an average of 332 veterinary inspectors on full time. Thus there was a total of 948 veterinarians engaged in the work regularly throughout the year, which is an increase of approximately 59 full-time employees compared with the preceding year.

The Federal appropriation for the work was \$6,361,000, of which \$1,190,000 was allotted for operating expenses and \$5,171,000 for paying indemnity to owners for cattle condemned as a result of the test. The combined State and county appropriations amounted to more than \$13,500,000.

The plans for the work now include (1) the eradication of tuberculosis under the accredited-herd plan, (2) eradication under the area plan, (3) the eradication of tuberculosis from swine, (4) investigations relative to interstate shipments, (5) tuberculosis in fowls, and (6) the control and eradication of Johne's disease (paratuberculosis).

The retesting of cattle in modified accredited areas has resulted in conclusive evidence that bovine tuberculosis can be kept at a minimum provided proper attention is given to the necessary sanitary

measures. A striking instance was found in a retest of 187,678 cattle in four counties in Wisconsin. This retest, which included all the cattle in the four counties, resulted in the disclosure of only 189 reactors, or approximately 1 among every 1,000 cattle tested.

The tuberculin testing of all the cattle in Michigan was completed during the year. However, owing to an injunction suit in Ionia County, that county could not be "modified" until August 1, 1930. This injunction suit was decided in favor of the State. All the other counties in the State were in the modified accredited area July 1, signifying that the extent of tuberculosis among cattle does not exceed one-half of 1 per cent.

The legislature of the State of New York appropriated \$400,000 for use in employing accredited veterinarians to retest accredited herds of that State. This work was formerly paid for by the cattle owners. The term "accredited," as applied to veterinarians, signifies those who have received Federal and State approval and have demonstrated their knowledge of tuberculosis-eradication work by reason of having passed a satisfactory examination.

RESULTS OF BIENNIAL SURVEYS

The fifth survey to determine the approximate extent of bovine tuberculosis in the various counties in the United States was completed May 1, 1930. This survey indicated that the approximate degree of disease among cattle had been reduced to 1.7 per cent. The first survey was made in 1922, when 4 per cent of all the cattle were found to be affected with tuberculosis. In the latest survey it was found that in 2,721 counties of the total 3,072 counties in the United States the degree of infection did not exceed 1 per cent. In the more heavily infected areas where the degree of infection exceeds 7 per cent, there were found to be 121 counties; however, this area contains only 5.2 per cent of the cattle population of the United States. This survey further showed that 83 per cent of all the cattle in the United States are in areas in which bovine tuberculosis does not exceed 1 per cent. The usual maps were prepared and distributed showing the degree of infection of bovine tuberculosis by counties throughout the United States.

PROGRESS IN TUBERCULIN TESTING

The total number of herds and cattle under supervision up to the end of the year were 2,919,513 and 27,692,306, respectively. It is also noteworthy that 23 States report that more than 50 per cent of their cattle population are under such supervision. These States are led by North Carolina, Maine, and Michigan, in which all the cattle have been tuberculin tested and the entire State listed as a modified accredited area. As an indication of the continued interest in the work throughout the United States, there was at the end of the year a waiting list of more than 221,884 herds containing 2,108,015 cattle.

Marked increase in the herds under supervision as the result of accredited-herd work and area work necessitated the tuberculin testing of 1,102,423 herds, including 12,845,871 cattle. These fig-

ures include cattle tested for interstate shipment. The testing resulted in the removal of 216,932 reactors, or 1.7 per cent, which is the smallest percentage since the beginning of the work. It is noteworthy, as shown in Table 28, that since 1917 1,979,911 reactors have been removed from the cattle herds of the Nation without serious economic disturbance or creating any shortage of the necessary milk supply.

Accredited practicing veterinarians continued to cooperate, their work showing an increase of approximately 7 per cent over 1929 in the volume of testing conducted. This class of veterinarians tested during the year 103,963 herds containing more than 1,543,287 cattle at the expense of the livestock owners.

ACCREDITED TUBERCULOSIS-FREE HERDS

TABLE 28.—*Progress of tuberculin testing under accredited-herd and area plans, 1917–1930*

Year ended June 30—	Cattle tested					Modi- fied accred- ited coun- ties	Herds accred- ited ¹	Herds passed one test ¹	Herds under super- vision ¹
	Accred- ited-herd plan	Area plan	Total	Reactors found	Per cent of re- actors				
	<i>Number</i>	<i>Number</i>	<i>Number</i>	<i>Number</i>		<i>Number</i>	<i>Number</i>	<i>Number</i>	<i>Number</i>
1917-----	20, 101	-----	20, 101	645	3.2	-----	-----	-----	-----
1918-----	134, 143	-----	134, 143	6, 544	4.9	-----	204	883	-----
1919-----	329, 878	-----	329, 878	13, 528	4.1	-----	578	5, 652	-----
1920-----	700, 670	-----	700, 670	28, 709	4.1	-----	2, 588	10, 064	-----
1921-----	1, 366, 358	-----	1, 366, 358	53, 768	3.9	-----	4, 831	33, 215	71, 806
1922-----	1, 722, 209	² 662, 027	2, 384, 236	82, 569	3.5	-----	8, 015	111, 719	140, 376
1923-----	1, 695, 662	1, 765, 187	3, 460, 849	113, 844	3.3	-----	12, 310	150, 748	187, 915
1924-----	1, 865, 863	3, 446, 501	5, 312, 364	171, 559	3.2	38	19, 747	216, 737	305, 809
1925-----	2, 008, 526	4, 991, 502	7, 000, 028	214, 491	3.1	51	24, 110	392, 740	414, 620
1926-----	1, 989, 048	6, 661, 732	8, 650, 780	323, 084	3.7	109	24, 009	382, 674	435, 840
1927-----	2, 522, 791	7, 177, 385	9, 700, 176	285, 361	2.9	149	34, 084	229, 086	261, 148
1928-----	2, 589, 844	8, 691, 646	11, 281, 490	262, 113	2.3	180	38, 880	427, 595	473, 218
1929-----	2, 853, 633	8, 830, 087	11, 683, 720	206, 764	1.8	213	1, 639	249, 420	281, 323
1930-----	2, 953, 350	9, 892, 521	12, 845, 871	216, 932	1.7	236	11, 863	227, 921	347, 448
Total.	22, 752, 076	52, 118, 588	74, 870, 664	1, 979, 911	2.6	³ 976	182, 858	2, 438, 454	2, 919, 503

¹ The figures in these columns represent net increases at the close of each year.

² Testing during six months.

³ Not including parts of 3 counties and 43 towns.

ERADICATION OF TUBERCULOSIS FROM AREAS

The area work has continued to grow, indicating both the efficiency and popularity of this plan. Approximately 77 per cent of all the cattle tested in the work of eradication were tested under the area plan. At the conclusion of the year 1,413 counties and the District of Columbia had engaged in area work. This is an increase of 213 counties, or approximately 18 per cent, over the number for the preceding year. County expenditures for the furtherance of area work were approximately \$1,300,000.

At the conclusion of the year the modified accredited area included 976 counties, 43 towns, and parts of 3 other counties. This is in comparison with 740 such areas at the end of 1929. Field reports indicate that at the completion of the year 31.8 per cent of the total counties in the United States were in the modified accredited class, and that including the modified counties 46 per cent of the entire

number of counties in the United States were engaged in eradicating the disease from their livestock. Table 29 indicates the status of area work on June 30, 1930.

TABLE 29.—*Status of tuberculosis eradication from county areas at close of fiscal year 1930*

State	Counties completing one or more tests of all cattle ¹	Counties intensively engaged in testing	Total counties engaged ¹	Modified accredited areas	Cattle tested during year
Alabama.....	0	3	3	0	58,152
Arizona.....	0	2	2	0	36,698
Arkansas.....	1	2	3	1	12,224
California.....	6	3	9	5	128,442
Colorado.....	0	2	2	0	3,181
Connecticut.....	0	4	4	0	46,860
Delaware.....	1	0	1	1	12,767
District of Columbia.....	1	0	1	0	837
Florida.....	2	0	2	0	0
Georgia.....	29	3	32	27	65,426
Idaho.....	35	7	42	35	99,360
Illinois.....	49	41	90	49	970,984
Indiana.....	84	3	87	80	239,099
Iowa.....	59	35	94	54	1,107,353
Kansas.....	50	2	52	50	218,928
Kentucky.....	61	3	64	43	88,917
Maine.....	16	0	16	16	42,924
Maryland.....	8	9	17	1	115,170
Massachusetts.....	1	2	3	1	30,224
Michigan.....	83	0	83	82	615,335
Minnesota.....	49	0	49	47	905,776
Mississippi.....	7	1	8	6	37,330
Missouri.....	13	5	18	12	102,072
Montana.....	² 13	² 0	14	² 13	12,695
Nebraska.....	44	2	46	42	411,373
Nevada.....	3	10	13	3	24,674
New Hampshire.....	2	4	6	2	28,379
New Mexico.....	0	19	19	0	14,447
New York.....	26	29	55	12	594,686
North Carolina.....	100	0	100	100	12,506
North Dakota.....	38	5	43	36	96,083
Ohio.....	60	14	74	51	687,756
Oklahoma.....	1	1	2	1	39,912
Oregon.....	14	14	28	8	137,726
Pennsylvania.....	31	28	59	31	580,106
South Carolina.....	16	3	19	16	37,889
South Dakota.....	6	0	6	5	90,648
Tennessee.....	13	5	18	13	81,610
Texas.....	1	1	2	1	64,356
Utah.....	2	26	28	1	89,325
Vermont.....	(³)	8	8	(³)	60,889
Virginia.....	37	15	52	36	134,523
Washington.....	⁴ 18	⁴ 15	35	⁴ 15	210,017
West Virginia.....	27	7	34	27	99,747
Wisconsin.....	71	0	71	53	1,445,115
Total.....	⁵ 1,078	333	1,414	⁵ 976	9,892,521

¹ Including District of Columbia.

² Not including part of 1 county.

³ Not including 43 towns.

⁴ Not including part of 2 counties.

⁵ Not including part of 3 counties and 43 towns.

STATISTICS OF SLAUGHTER AND INDEMNITY

Continued attention was given to the marketing of reactor cattle. The large number of such animals thrown on the markets makes this an important phase of the cooperative work. As indicated by the average salvage per head, shown in Table 30, these efforts have been fruitful, though aided by a high average market price for beef cattle throughout the year. Visits were made by State and bureau

workers to public stockyards, packing houses, commission agencies, and others whenever it was suspected that better prices might be obtained. The average salvage for 1930, as will be noted in Table 30, was \$42.11.

TABLE 30.—*Cattle slaughtered, appraised value, indemnity allowed, and salvage realized in work of tuberculosis eradication, fiscal year 1930*

State	Cattle slaugh- tered	Average appraisal per head	Indemnity		Average indem- nity per head		Average salvage per head
			State	Federal	State	Federal	
	<i>Number</i>	<i>Dollars</i>	<i>Dollars</i>	<i>Dollars</i>	<i>Dollars</i>	<i>Dollars</i>	<i>Dollars</i>
Alaska.....	12	183.34	828.35	455.00	69.03	37.92	0.00
Arizona.....	399	140.13	10,385.71	10,385.71	26.03	26.03	37.17
California.....	2	95.00	46.74	40.10	23.37	20.05	27.83
Colorado.....	184	127.80	4,452.23	4,442.29	24.20	24.14	49.58
Connecticut.....	3,448	112.58	163,212.89	82,699.54	47.34	23.98	39.25
Delaware.....	1,937	105.97	66,195.71	46,319.24	34.17	23.91	33.37
District of Columbia.....	1	160.00	.00	22.00	.00	22.00	55.00
Florida.....	165	34.13	2,825.96	1,413.74	17.13	8.57	8.35
Georgia.....	39	78.46	848.84	848.84	21.77	21.77	18.03
Hawaii.....	215	219.36	21,228.00	6,191.22	98.73	28.80	51.05
Idaho.....	136	87.79	2,905.57	2,905.57	21.36	21.36	23.78
Illinois.....	19,280	138.47	536,815.03	536,815.03	27.84	27.84	49.78
Indiana.....	846	123.28	21,608.69	21,113.44	25.54	24.96	43.83
Iowa.....	12,513	122.88	319,462.11	312,366.31	25.53	24.96	45.07
Kansas.....	984	96.88	18,615.25	18,513.64	18.92	18.81	40.78
Kentucky.....	200	81.28	6,121.43	3,379.23	30.60	16.90	28.51
Louisiana.....	50	51.50	416.62	285.73	8.33	5.71	36.68
Maine ¹	316	123.96	26,422.17	8,855.18	83.61	28.02	28.27
Maryland.....	3,146	110.18	76,477.88	76,477.88	24.31	24.31	38.04
Massachusetts.....	7,766	156.50	378,520.01	267,798.52	48.74	34.48	39.80
Michigan.....	2,407	164.92	79,995.50	76,723.22	33.23	31.87	41.87
Minnesota.....	6,945	101.15	129,913.16	111,735.28	18.71	16.09	49.46
Mississippi.....	3	51.00	51.00	51.00	17.00	17.00	.00
Missouri.....	307	127.17	7,060.47	7,060.47	23.00	23.00	34.55
Montana ¹	138	45.08	4,656.83	1,577.96	33.74	11.43	¹ 10.75
Nebraska.....	2,385	121.21	50,481.33	50,481.33	21.17	21.17	47.31
Nevada.....	58	51.47	655.95	590.32	11.31	10.18	19.04
New Hampshire.....	2,277	88.17	85,247.99	44,192.27	37.44	19.41	29.20
New Jersey.....	4,009	144.88	261,505.48	128,744.98	65.23	32.11	40.12
New Mexico.....	87	122.09	2,368.09	2,368.09	27.22	27.22	28.85
New York.....	30,186	142.82	2,397,371.16	710,369.06	79.42	23.53	38.83
North Carolina.....	33	112.55	725.10	725.10	21.97	21.97	21.86
North Dakota.....	1,315	78.72	16,527.20	16,527.20	12.57	12.57	40.83
Ohio.....	9,833	168.38	350,926.62	343,277.97	35.69	34.91	46.20
Oklahoma.....	164	109.27	3,949.97	3,421.51	24.09	20.86	37.05
Oregon.....	225	135.04	3,709.53	3,709.53	16.49	16.49	37.71
Pennsylvania.....	19,386	157.83	763,295.49	645,293.54	39.37	33.29	43.55
Rhode Island.....	991	144.61	52,702.50	30,358.48	53.18	30.63	47.75
South Carolina.....	34	86.03	892.40	842.92	26.25	24.79	9.29
South Dakota.....	1,123	99.93	19,807.95	19,807.95	17.64	17.64	43.03
Tennessee.....	57	121.72	1,694.02	1,506.55	29.72	26.43	31.45
Texas.....	474	123.83	12,969.92	12,969.92	27.36	27.36	28.35
Utah.....	457	124.07	12,778.87	12,766.71	27.96	27.94	35.93
Vermont.....	6,501	91.23	154,753.93	154,753.93	23.80	23.80	19.64
Virginia.....	626	121.57	14,756.80	14,706.85	23.57	23.49	31.76
Washington.....	2,061	130.11	51,529.40	51,529.40	25.00	25.00	40.05
West Virginia.....	271	94.47	8,755.37	4,341.06	32.31	16.02	27.08
Wisconsin.....	16,984	141.38	359,719.65	359,719.65	21.18	21.18	46.40
Wyoming.....	38	101.32	484.43	466.90	12.75	12.29	13.63
Total.....	161,014	136.20	6,506,675.30	4,211,947.36	40.41	26.16	42.11

¹ Salvage paid to State.

ERADICATION OF TUBERCULOSIS FROM SWINE AND FOWLS

The voluntary payment of 10 cents per hundredweight, paid by certain packers, for hogs originating in modified accredited areas was discontinued June 1, 1930.

Tuberculosis eradication work in poultry included giving poultry owners information on the need of proper sanitation, maintenance of

flocks under the best conditions of poultry husbandry, and the use of the tuberculin test when necessary for the diagnosis of the disease. The survey of farm poultry flocks in connection with the testing of cattle, begun several years ago, was continued. During the year 177,156 flocks, containing approximately 18,931,451 fowls, in 25 States, were inspected. Nearly 11,800 of these flocks were found to be infected with tuberculosis, as indicated by cases of the disease in the flocks. These inspections were made by veterinarians engaged in the testing of cattle and with very little additional cost to the department.

REGULATION OF INTERSTATE MOVEMENT OF CATTLE

Under the provisions of regulation 7, Bureau of Animal Industry Order 309, the approved veterinary practitioners throughout the 48 States continue to conduct most of the tuberculin testing for interstate shipments of cattle. There were on the list of approved veterinarians on June 30, 1930, more than 9,600 veterinary practitioners, who, under a cooperative plan, are approved by the State and Federal livestock sanitary officials. These men tested for interstate shipment 26,493 lots containing 338,612 cattle, of which 0.4 per cent reacted. The number tested is a decrease of 126,262 cattle from that reported during 1929.

In an effort to assist livestock owners in facilitating the interstate movement of cattle there were tested by bureau inspectors, under the provisions of the regulations at public stockyards, 41,299 cattle, of which 0.6 per cent reacted. These figures of testing by bureau and approved veterinarians are included in the total testing for the year as reported in Table 28.

Interstate transportation of reactor cattle, also under the provisions of regulation 7, for the purpose of immediate slaughter, was continued under the permit system. Permits were issued covering the movement of 42,658 such cattle. The regulations permit the return of breeding cattle to the point of origin when they have been moved interstate and have reacted after delivery. No permits were issued covering the return of such animals. Permits were issued covering the interstate movement of 22,999 bull calves under 6 months of age, subject to castration at destination.

TUBERCULIN TESTING

Table 31 shows the relative use of the various methods of tuberculin testing as reported. The total varies somewhat from the total tests for the year in Table 28 because some of the reports did not state the method of testing.

TABLE 31.—*Relative use of tuberculin-testing methods, fiscal year 1930*

Test employed	Cattle tested	Reactors found	Reactors
	<i>Number</i>	<i>Number</i>	<i>Per cent</i>
Intradermic alone.....	11, 194, 386	150, 137	1.3
Subcutaneous alone.....	1, 565	39	2.5
Ophthalmic alone.....	944	14	1.5
Combination of tests.....	1, 275, 821	63, 645	5.0
Total.....	12, 472, 716	213, 835	1.7

Of the cattle reported as tested in Table 28, about 16.8 per cent were tested by bureau inspectors and about 83.2 per cent by State, municipal, and accredited practicing veterinarians. Considerable pressure was brought to bear on field offices to insure a sufficient amount of field supervision to maintain the tuberculin test at its highest possible efficiency. With approximately 948 veterinarians engaged daily in the work, it can be seen that this was necessary in order that the high standards, established in the past, might be maintained. Attention was again given the so-called no-visible-lesion cases noted on post-mortem examination of slaughtered reacting cattle. More than half of such cases were found to have originated in herds known to harbor infection.

This supervision of field veterinarians was also maintained so as to reduce the average cost of testing per head. The standard of professional service rendered by the field veterinarians continued to be of a high degree of excellence.

CONFERENCES AND PUBLICITY ON TUBERCULOSIS ERADICATION

The eleventh annual Eastern States conference on tuberculosis was held at Albany, N. Y., June 3, 4, and 5. The regular mid-Western States conference was held at Cedar Rapids, Iowa, April 29 and 30, and the regular Southwestern States conference was held at Little Rock, Ark., May 5 and 6. All these conferences were well attended, and were the means of disseminating valuable information to those interested in the project of eradicating tuberculosis among livestock. An exhibit suitable for display at these conferences and on other occasions where people are interested in the subject was prepared by the bureau. This consists of pictures of a cow, a hog, and a hen, arranged so as to display the internal organs which are often affected with tuberculosis. The exhibit is made very attractive by an electrical arrangement that illuminates it.

DIVISION OF VIRUS-SERUM CONTROL

The activities of this division, consisting of the administrative and regulatory work under the virus-serum-toxin act of 1913, were continued under the direction of D. I. Skidmore, chief. The work consists chiefly in the issuance of licenses to establishments producing veterinary biological products intended for sale in interstate commerce, the inspection of sanitary conditions of producing laboratories and methods of production and testing of biologics, and the certification of products for export. It also includes the issuance of permits to import biologics from abroad, together with the inspection of shipments of such biologics at ports of entry.

WORK AT LICENSED ESTABLISHMENTS

At the close of the year supervision was exercised over 84 licensed establishments in 59 cities and towns in 22 States as compared with 88 establishments in 61 cities and towns at the close of the preceding fiscal year. At the close of the year 45 establishments were engaged in producing only anti-hog-cholera serum and hog-cholera virus, 32 were producing other biologics only, and 7 were producing both

classes of products. Inspectors of the bureau supervised the production and testing of anti-hog-cholera serum and hog-cholera virus, and also conducted tests to determine whether these products were preserved properly. They also made periodical visits of inspection to establishments producing other biologics. Samples of biologics, as well as cultures of organisms used in their production, were collected for examination at the time of many of these visits.

Amendment No. 6 to B. A. I. Order 276, which became effective April 1, 1930, discontinued the production of "diluted" or unconcentrated clear anti-hog-cholera serum by licensed establishments. The marketing of this type of serum is permitted, however, until December 31, 1930, in order that all on hand may be used.

During the year most licensed establishments installed improved equipment for handling and heating clear serum. The equipment provided is such that the product can be satisfactorily handled and heated in much larger quantities or bulk than formerly. Examinations of a number of samples of serum so handled indicate that it is commercially practicable to prepare a satisfactory pasteurized serum.

During the year an average of 89 inspectors was maintained in the field. These inspectors examined and admitted to licensed establishments 399,205 hogs and 1,184 calves. Of these, 49 hogs were rejected at the time they were offered for admission and 22,826 hogs were rejected after admission because of conditions which made them unsuitable for the production or testing of biologics. The inspectors also collected samples from 3,687 batches of anti-hog-cholera serum and from 3,263 batches of simultaneous virus. There were supervised 5,134 potency and 4,093 purity tests of anti-hog-cholera serum and 3,313 purity tests of simultaneous virus.

Inspectors of the division collected for laboratory examination 193 samples of biologics or material intended for use in preparing them. On examination the bureau found 153 of these samples to be satisfactory and 40 unsatisfactory or contaminated. Three hundred and fifty-four strains of organisms intended for use in the preparation of biologics by establishments were collected and submitted for laboratory examination. Of these, 295 were satisfactory and 59 unsatisfactory or contaminated.

OUTPUT OF BIOLOGIC PRODUCTS

During the year licensed establishments produced 852,185,457 cubic centimeters of anti-hog-cholera serum, of which 216,637,164 cubic centimeters (25.42 per cent) was defibrinated-blood serum and 635,548,293 cubic centimeters (74.58 per cent) was clarified serum. Since all clear serum now is concentrated as compared to defibrinated-blood serum, the percentage of the clear product on a dosage basis is considerably larger than these figures indicate. The quantity of simultaneous hog-cholera virus produced by these establishments was 61,564,599 cubic centimeters, while their production of hyperimmunizing virus amounted to 172,514,428 cubic centimeters and of inoculating virus 780,434 cubic centimeters, so that the total quantity of virus produced was 234,859,461 cubic centimeters.

The quantity of other biologics produced by licensed establishments aggregated 39,594,374 doses, classified as follows: Aggressins,

10,992,194; antisera and normal sera, 1,529,613; bacterins, 14,141,554; vaccines and viruses, 7,478,506; mallein, 89,851; pullorin, 1,731,570; tuberculin, 3,125,551; avian tuberculin, 505,535.

PRODUCTS REJECTED

The quantity of anti-hog-cholera serum destroyed as unfit for use in the treatment of animals aggregated 5,691,230 cubic centimeters. Of this quantity 3,484,481 cubic centimeters were derived from animals affected with diseases such as tuberculosis, pneumonia, and septicemia, and the remaining 2,206,749 cubic centimeters were destroyed because of contamination in the process of manufacture or on account of other conditions which rendered the product unfit for use.

The total quantity of simultaneous virus destroyed aggregated 2,056,135 cubic centimeters, of which 1,111,350 cubic centimeters were destroyed on account of being derived from diseased animals, and 944,785 cubic centimeters because of contamination or other undesirable conditions.

The total quantity of hyperimmunizing virus destroyed was 5,569,198 cubic centimeters, of which 4,975,190 cubic centimeters were destroyed on account of disease and 594,008 cubic centimeters because of contamination or other undesirable conditions.

EXPORTS AND IMPORTS OF BIOLOGIC PRODUCTS

In cooperation with the Treasury and Post Office Departments and the Food and Drug Administration of the Department of Agriculture, the bureau exercises control over the importation of veterinary biologics. At the close of the year two permits to import such products were outstanding. Many insistent applications were received to import products that could not be admitted. Bureau inspectors examined at the port of entry 33 shipments of biologics offered for importation. Of these, 20 were found to be biologics exported from the United States which had been returned for various reasons. Of the remaining 13, 8 were admitted and 5 denied entry or destroyed because they were not eligible for importation into this country.

During the year 530 certificates to accompany shipments of veterinary biologics to 26 foreign countries were issued by bureau inspectors. Although certificates are not required in all cases the total of all export shipments reported to the bureau aggregated 30,238,089 cubic centimeters. Of this quantity anti-hog-cholera serum constituted the major portion, or 27,271,815 cubic centimeters.

ZOOLOGICAL DIVISION

The scientific investigation of animal parasites and the practical application of control measures along lines of treatment and prevention were continued under the direction of Maurice C. Hall, chief.

The most important development of the year, from the standpoint of the broad field of parasitology as a whole, was the establishment of a small experiment station at Beltsville, Md. This station will be used for small-scale studies of parasites on fields, pastures, and

other inclosures, to ascertain the relations of parasite longevity and survival to such factors as soil texture, vegetation, moisture, temperature, and sunlight. Laboratory findings developed at Washington will be applied at the station in small-scale tests, and the control measures developed will be given large-scale tests in cooperation with stockmen at various places, and will then be turned over to veterinarians, the extension service, and the public as practical control measures. At present the station has a temporary laboratory building and 5 acres of cleared land, of which 4 are in pasture.

PARASITES OF POULTRY

COOPERATIVE STUDIES

Cooperative studies of the parasites of game birds included the completion, with the Bureau of Biological Survey, of an investigation of the internal parasites of quail of the Southeastern States, and also an investigation of the relation of parasites to "duck sickness" at Klamath Falls, Oreg. In the former case data were obtained concerning the kind, prevalence, and distribution of the parasites. The essential results are contained in a report prepared by the Bureau of Biological Survey and now in course of publication. In the latter case, although the percentage of infestation with parasites was high, a study of the identity of the parasites failed to reveal a predominance of one species, and it was concluded that "duck sickness" was not correlated with parasitic infestation.

With the New England ruffed grouse investigation committee there was undertaken a cooperative study of the internal parasites of the ruffed grouse, this study consisting of the identification of specimens and the conducting of experiments on the life history and pathological significance of the parasites.

In connection with the raising of turkeys in Montana by the Animal Husbandry Division a study has been carried on to observe the time at which parasites appear in a flock which is being raised on "clean" soil, that is, not used previously for poultry of any kind and remote from areas on which there are turkeys or chickens, and, if possible, to determine the means by which parasites gain entry to the flock. An extensive investigation of the parasites of wild birds in that area was conducted because of its bearing on the possible appearance of any parasites in the turkeys. Parasites were collected during the year from 90 such birds out of 168 examined.

NEMATODES

Life-history investigations were continued, and in the case of two additional species of nematodes, both of which occur in the glandular stomach of poultry and gallinaceous game birds, the intermediate hosts have been discovered, namely, certain sow bugs serving as intermediate hosts for *Dispharynx spiralis*, and a cockroach serving for *Seurocyrnea colini*.

Cross transmission of nematodes from one species of bird to another was effected in the following instances: *Tetrameres americana* and *Strongyloides avium* from chickens to bobwhite quail and ruffed grouse; *Capillaria columbae* from pigeons to chickens;

Cheilospirura spinosa from ruffed grouse to quail; *Dispharynx spiralis* from ruffed grouse to quail and pigeons (but not to chickens); *Capillaria contorta* from pheasants to quail and ducks (but not to chickens); and *C. retusa* from the Hungarian partridge to quail.

There were discovered in wild birds natural infections of nematodes which are pathogenic for domestic birds in Montana, Virginia, and North Carolina.

CESTODES

Work on life-history problems of poultry tapeworms has been continued. Three additional species of ground beetles have been found to be intermediate hosts for the tapeworm *Raillietina cestillus*. One additional species of dung beetle has been reported as an intermediate host of *Hymenolepis carioca*. Larval stages of the small tapeworm, *Davainea proglottina*, were developed in a common pond snail. Larval stages of a tapeworm of turkeys, *Metroliasthes lucida*, have been developed in grasshoppers.

A new species of tapeworm, *Raillietina* (*Paroniella*) *magninumida*, from the guinea fowl was found to develop in a ground beetle.

TREMATODES

In connection with a study of the snail hosts of the salmon-poisoning fluke, a monostome cercaria was found which was later shown experimentally to be the larva of a fluke parasitic in the ceca of domesticated ducks.

PROTOZOA

Research is being conducted on the control of coccidiosis of chickens. The problem, at present, is primarily to determine the value of various rations and of their separate constituents in increasing the resistance of chickens to this disease. Only one species of coccidium, *Eimeria tenella*, has been used thus far in these experiments, this form producing the cecal type of coccidiosis, which is considered to be the most virulent form of the disease in chickens. The results indicate that resistance to coccidiosis as a clinical and zoological entity may be increased by a suitable ration.

Investigations were made of a quail epizootic near Richmond, Va. It was found that the birds, many of which were dying, were heavily infected with a species of *Trichomonas* apparently different from *T. gallinarum* of the chicken.

PARASITES OF SWINE

NEMATODES

In the course of the year the bureau received reports of an unusually large number of cases of human trichinosis, and it became necessary to lay a foundation for new control measures for this disease. Experiments were conducted to determine whether experimental trichinosis in pigs might be diagnosed by skin tests, as it can thus be diagnosed in rabbits. A method for preparing trichina antigen free from muscle tissue was devised, and this antigen has been tested

on about a dozen pigs experimentally infested with trichinae. The results obtained have been decidedly encouraging.

Following the discovery by a European investigator that earthworms serve as intermediate hosts of swine lungworms, experiments were undertaken with a view to confirming this discovery and also with a view to determining the species of earthworms in the United States which act as intermediate hosts of swine lungworms. It was found that earthworms ingest lungworm larvae with soil and the larvae develop in the wall of the esophagus and often penetrate the earthworm's circulatory system, becoming arrested, for the most part, in the heart. Infestation in pigs results from swallowing infested earthworms.

Field investigations carried out at points in Maryland, southern Georgia, and eastern North Carolina showed that earthworms collected in hog lots, hog pastures, hog manure, and in various other places which have become contaminated with hog manure are infested with lungworm larvae. Frequently natural infestations in earthworms are heavier than those which have been produced experimentally in the laboratory as a result of feeding rich cultures of larvae. In one case earthworms obtained from a pasture from which hogs had been absent for four months or longer were still infested with lungworm larvae, thus indicating that the infestations in earthworms may persist for months after the sources of infestation have been removed. This point has also been verified in laboratory experiments.

Further experiments carried out during the year have confirmed earlier investigations, already reported, with reference to the life history of kidney worms. The fact that the intact skin of swine is an effective barrier against the entrance of the larvae into the body has been definitely established. It has also been determined by direct observation that mature kidney worms which occur in the perirenal fat and establish fistulous tracts to the ureter are capable of penetrating and perforating the ureter.

Investigations carried out on farms in southern Georgia with reference to the survival of kidney-worm larvae on pastures, on soil, and in and around hog wallows have yielded results which in the main confirm findings made under laboratory conditions, with reference to the lack of resistance of these larvae to unfavorable conditions. Numerous examinations of samples of soil from hog lots and pastures were made with a view to finding kidney-worm larvae. No larvae were found in and around wallows. Larvae were found most frequently in and underneath corn husks, bean pods, and trash. Larvae were also found on moist soil and at the base of moist grass.

These investigations have established the facts that kidney-worm larvae are rapidly destroyed by dryness, exposure to the sun, and in wallows, and that such conditions as moisture and shade favor their survival. Investigations with reference to nodular worms have shown that in southern Georgia the predominant species of nodular worm during the fall and winter is *Oesophagostomum longicaudum*, which is apparently responsible for the production of inflamed nodules in the mucosa of the large intestine; during the spring months a different species of nodular worm, *O. dentatum*, predominates; this species is apparently not responsible for the production of inflamed nodules.

The swine-sanitation work begun in Georgia in 1926 has been continued and has attracted much attention in that and surrounding States. During the year 19 farmers used the sanitation system. Their pigs were ready for market 50 days earlier and weighed 29 pounds more on an average than pigs raised by farmers not using the system. On post-mortem examination the parasite findings were: Livers parasitized in sanitation pigs, 72 per cent, in check pigs, 85 per cent; kidney region parasitized in sanitation pigs, 34 per cent, in check pigs, 80 per cent. In general the swine growers using the sanitation system profited from it to the extent of 29 pounds more weight per pig and a saving of the cost of 50 days' feed per pig, and they had 13 per cent fewer pigs with parasitized livers and 46 per cent fewer pigs with parasitized kidneys and kidney fat.

PARASITES OF RUMINANTS

NEMATODES

In experimental work at McNeill, Miss., eight lots of scrub "piney woods" sheep had been kept under various measures for controlling internal parasites. Ten sheep were in each lot. From the original 80 animals there were, after two years, 38 survivors. The deaths occurred principally during the first year of the experiment. In most of the lots the method of control was medicinal treatment once every two weeks throughout the year. The drugs used were copper-sulphate solution, copper-sulphate and nicotine-sulphate solution, copper-sulphate alternated with nicotine-sulphate solution, carbon tetrachloride, and tetrachlorethylene. After two years of this intensive treatment the 38 survivors were slaughtered and each was given a thorough post-mortem examination for parasites.

No sheep was found completely free of parasites, but the original infestations had been greatly diminished and some worm species failed to appear in any of them. Nine of ten sheep in an untreated check lot died rather promptly from worms. The initial weights of the 80 sheep averaged 36.8 pounds, whereas the final weights of the 38 survivors averaged 96 pounds, a striking result with scrub southern sheep.

A *Strongyloides* was found for the first time in American cattle and its life history studied. In no case did the usual free-living males and females develop from the eggs of the parasites; in all cases there was direct development to infective larvae.

Studies of the disposal of cow manure by the use of boxes of special construction were carried out along the same lines as previous studies of the disposal of horse manure mentioned in last year's report, and it was found that as good results were obtained in the destruction of parasite eggs and larvae from heat spontaneously generated in cow manure as in horse manure.

TREMATODES

The field work on the control of liver flukes in sheep and cattle was continued in California. Excellent results were obtained in connection with flukes in sheep. The areas in which work was carried out the previous year reported no trouble from flukes and there was

a marked benefit in the way of increased thrift in sheep. The areas of work were extended.

The previous year more than 50,000 sheep were treated with carbon tetrachloride without fatalities from the drugs, but last year in five flocks the drug caused losses of from 2½ to 10 per cent. In all cases where losses occurred the sheep had been moved from native pastures to cultivated crops or put on feed. It was concluded that the losses following treatment with the drug were associated with metabolic changes following the change from a sustaining ration on pasture to a fattening ration. Accordingly sheepmen were advised to put all sheep not already on pasture back on pasture for a few days before treating and to keep them there for a few days after treatment. Since the time this procedure was followed there have been losses from carbon tetrachloride in one flock only; in that case the sheep were on wet, succulent pasture.

The control of liver fluke in cattle has not been so satisfactory. Cattlemen have not had the same incentive from death losses that the sheepmen have had, although the losses from flukey cattle livers for which packers made deductions in purchasing are heavy. The carbon-tetrachloride treatment has not been recommended for flukes in cattle, since there are dangers attending its use on these animals. Moreover, the cattlemen have not yet cooperated to a very great extent in the program of draining, filling in, and fencing off wet areas or using copper sulphate to poison snails in which the fluke spends part of its life cycle.

An extensive survey was made to determine the snails serving as intermediate hosts of the sheep and cattle liver flukes. *Galba bulimoides* was found to be the intermediate host of the common sheep-liver fluke, usually known as *Fasciola hepatica*, in the Northwest and on the Pacific Coast. A variety of this snail, *G. b. techella*, serves as the intermediate host in the Southwest and South outside of Florida. In Florida the distribution of the fluke appears to coincide with the distribution of *G. cubensis*, and it is probable that this is the intermediate host in Florida. In the Intermountain States there are at least two, and possibly three, species of *Galba* which may serve as hosts. Life-history and morphological investigations indicate that the flukes known as *F. hepatica* may possibly belong to at least two varieties or possibly species. Investigations in Texas on the previously unknown life history of the large liver fluke of cattle, *Fascioloides magna*, demonstrated that *G. b. techella* is the intermediate host of this fluke as well as of *Fasciola hepatica*.

PROTOZOA

The principal line of investigation on anaplasmosis has been to ascertain whether ticks carry the disease. Up to the end of last year experiments indicate that one of the dog ticks, *Rhipicephalus sanguineus*, can carry the disease. In all probability other ticks will be incriminated. Experiments have shown that both anaplasmosis and piroplasmiasis may be transmitted from infected to susceptible animals by pricking the ear of an infected animal with a lancet and then pricking the ear of a susceptible animal with the same lancet. These findings indicate nothing more as regards

the transmission of the disease than that what is true of piroplasmosis is still true of anaplasmosis, and that sponsors of theories in regard to the transmission of the former should take this fact into consideration.

INSECTS

Cooperative field investigations of cattle-grub control begun in July, 1928, were continued. The area used for this study in Prowers County, Colo., was enlarged from 150 to 260 square miles. Grub openings appeared in the Colorado cattle early in December and extraction of grubs with forceps was commenced December 18, 1929. The cattle in the area were worked three times. The third and last working was completed February 28, 1930.

Altogether 133 herds containing 5,614 cattle were worked. The voluminous data obtained included the number of grub-infested and grub-free cattle, the grubs per animal, and labor cost for handling the cattle when extracting the grubs.

The area used for cattle-grub investigation in Knox County, Ill., was enlarged by the addition of one township. Data of a character similar to that mentioned for Colorado were obtained. A preliminary report of the cattle-grub investigations in these two States was prepared for publication. Although the results are still inconclusive, they contain data of practical importance on the effect of age, sex, and color of cattle with relation to grub infestation and also on the relative cost of extracting grubs by forceps and vacuum apparatus. Thus far the use of forceps has proved to be the most economical for extracting grubs.

Tests were made with finely ground Derris root, rotenone content 2.25 per cent, and tobacco powder, nicotine content 2.56 per cent, applied dry in the hair coat of infested cattle every 30 days during the grub season. To test the effects of oils on the viability of eggs of *Hypoderma*, 36 head of Colorado cattle in 5 herds were treated with light lubricating oil; 512 head of Illinois cattle in 18 herds with linseed oil; and 10 head of Kansas cattle in 1 herd with cottonseed oil. During adult-fly activity the oils were applied to the entire hair coat of the cattle, except the face. Intervals between treatments varied from one to seven days. The results show that daily oiling greatly reduced infestation but did not entirely prevent it.

To test the killing power and proper dosage of rotenone on cattle grubs in situ six lots of medicated pins were used. Tubes of gelatin about $2\frac{1}{2}$ millimeters in diameter were filled by suction with melted cocoa butter in which the rotenone was dissolved. The results show that rotenone, when brought into direct contact with the grub, is highly effective.

PARASITES OF HORSES

NEMATODES

The cooperative work in the control of parasites of horses in a stud at Lexington, Ky., was continued, but the data have not yet been analyzed. Studies of the preparastic larvæ of the horse lung-worm were carried out.

Experiments at Miles City, Mont., in which one horse of each pair in 15 work teams was treated for the removal of nematodes, and

the other horse left untreated, showed a margin in favor of the treated animals as regards activity, endurance, and flesh, but the results were not striking.

Horse manure exposed to weather conditions on the pasture since July 31, 1928, still showed some active strongyle larvæ alive after almost two years of exposure to the hot, dry summers of Montana and its winters with frequent and protracted subzero temperatures.

MISCELLANEOUS PARASITES

NEMATODES

The cat lungworm, *Aeleurostrongylus abstrusus*, was found for the first time in the United States. Life-history studies confirmed the work of a British investigator, a cat becoming infected by eating mice to which the larvae of the lungworm had been fed.

TREMATODES

In an investigation of the life history of the salmon-poisoning fluke of dogs, *Nanophyetus salmincola*, the earlier findings of Oregon investigators incriminating *Goniobasis plicifera silicula* as the intermediate host were confirmed and the details of the life cycle worked out, including the method of infection of the secondary intermediate hosts, salmon and other fishes.

CESTODES

The tapeworms of North American carnivores are being studied and a monograph on the tapeworms of carnivores of the world is being prepared. An investigation of fish parasites in Oregon was carried out in cooperation with the Oregon Agricultural Experiment Station.

TREATMENTS FOR INTERNAL AND EXTERNAL PARASITISM

ANTHELMINTICS

The investigation of the chlorinated alkyl hydrocarbons has been continued, especially to determine the relative toxicity of the compounds involved, with special reference to pathological changes in the livers and kidneys. In general, this investigation indicates that the anthelmintic efficacy of these compounds for hookworms is correlated with the number of chlorine atoms and their position in the molecule. There appears to be a correlation between the water solubility of the compounds and their efficacy, the most soluble and the least soluble being the least effective, the optimum solubility in connection with anthelmintic efficacy lying between solubilities of 1 part of the compound in 1,500 parts of water to 1 in 2,000 parts of water. In general, the toxicity apparently decreases with the lengthening of the chain and increases when two or more chlorine atoms are spread over two or more carbon atoms.

In an experiment to ascertain whether sheep confined in small areas and treated with an anthelmintic once every week for a year could be freed of gastrointestinal parasites, the following results

were obtained: Weekly treatments with 100 cubic centimeters of a 1 per cent solution of copper sulphate, or 5 cubic centimeters of tetrachlorethylene, or 5 cubic centimeters of carbon tetrachloride failed to remove all the worms from the two sheep in each lot of three lots under treatment; the infestation was reduced to a low level and maintained there; none of the drugs had any effect on the gestation period of the ewes or caused abortion. Lambs born during the experiment and kept on the same areas without treatment showed a low level of infestation. The copper sulphate and tetrachlorethylene apparently were noninjurious to the sheep, but the carbon tetrachloride was injurious in dosing at weekly intervals and the sheep treated with it died in from eight to nine months.

INSECTICIDES

The work on this project has been confined for the most part to studies which are part of the ox-warble project, or to testing of proprietary insecticides in cooperation with the Food and Drug Administration.

INDEX CATALOGUE AND COLLECTIONS

The index catalogue of medical and veterinary zoology was continued and a new section added to cover systematically the invertebrate intermediate hosts of parasites of vertebrates. There were 707 accessions of specimens of parasites to the helminthological collection of the bureau. Three foreign visitors spent from two weeks to a year in the laboratory making use of its collections and catalogues.



REPORT OF THE CHIEF OF THE BUREAU OF BIOLOGICAL SURVEY

UNITED STATES DEPARTMENT OF AGRICULTURE,
BUREAU OF BIOLOGICAL SURVEY,
Washington, D. C., September 4, 1930.

SIR: I present herewith the report of the Bureau of Biological Survey for the fiscal year ended June 30, 1930.

Respectfully,

PAUL G. REDINGTON, *Chief.*

HON. ARTHUR M. HYDE,
Secretary of Agriculture.

FEDERAL WILD-LIFE ADMINISTRATION

The administration of wild life by the Bureau of Biological Survey involves research, reservation establishment and maintenance and other service activities, and regulatory functions under conservation laws. These have been popularly termed the three R's of wild-life conservation. Research in the relationships, habits, production, control, and conservation of wild life is essential and fundamental to all other work undertaken. Reservations must be set aside for the long-time benefit of the wild life that is more and more being crowded off its ancient feeding, breeding, and resting grounds by ever-increasing human occupation. Regulation of human operations in the use and enjoyment of wild life is essential to the immediate welfare of species that would otherwise be hunted to the point of extermination; control operations directed to suppress the depredations of predatory wild animals may also be termed an essential form of regulation, necessary both for the conservation of useful and harmless wild life and for economic reasons as well.

Other bureaus of the Federal Government are concerned with wild-life administrative functions, though limited for the most part to the specific areas under their jurisdiction. The Bureau of Biological Survey conducts special wild-life surveys on many such areas and cooperates in other ways with the administrative bureaus as requested. In addition, in the nature of its responsibilities as determined by Congress, the Biological Survey becomes a clearing house for information in general on the needs, habits, control, propagation, and relationships of the forms of vertebrate wild life other than the fishes. Its main field, from the time of its organization 45 years ago, has been the study of the wild birds and mammals of the country, extending, with the passage of years, to work for their conservation and control, and their propagation and utilization, including experiments in fur farming.

Increasing interest in wild-life conservation is making it every year more evident that wild-life administrators—Federal, State, and

local—must ever be on the alert for the welfare of the species under their guardianship. With all due regard for economic considerations they must bear in mind that their chief responsibility is for the protection of the wild life itself, and that as the duly constituted guardians of the various species they must be true to the trust imposed upon them. In spite of any pressure that may be exerted by organized groups and by individuals having special interests at stake they should perform their duty fearlessly and without favor. Such measures for wild-life conservation or control as are called for must be taken when dictated by thorough and careful investigation and consideration of all factors involved and of all results that are likely to follow.

Just as there must be research preliminary to definite operational programs, so it is essential to their greatest effectiveness that the results of research be made known to the public. The present facilities of the bureau do not permit the assignment of specialists to the sole duty of public lecturing and addressing conventions of conservationists, fur farmers, stockmen, and others whose work is influenced by the wild-life administrative functions of the Bureau of Biological Survey. Much, however, is being done by the bureau, both in the publication, so far as funds permit, of technical and popular official bulletins and in communicating developments to the press of the country and directly to the public by radio and other addresses given by the various members of the staff. In addition specialists of the bureau are constantly contributing articles in their own fields to the popular weekly and monthly magazines and to the outdoor, scientific, and trade journals of the country, thus effectively disseminating the information the public has a right to expect from the "wild-life service" of the Government.

OUTSTANDING EVENTS OF THE YEAR

Outstanding as mileposts affecting the work of the Bureau of Biological Survey during the year may be mentioned the following:

Completion of the food-resource surveys of all areas recommended as suitable for migratory-bird refuges, involving 189 units in 48 States, aggregating more than 3,700,000 acres, and determination of their biological fitness; and land-valuation surveys of 40 of the units, in 24 States, involving approximately 1,225,000 acres.

Authorization by the Migratory Bird Conservation Commission of the first two purchases recommended by the Biological Survey of areas under the new migratory-bird refuge program and the setting aside of two additional areas of public domain similarly recommended for the same purpose.

Congressional authorization of \$250,000 for the acquisition of the necessary areas of land and water for the establishment of the Cheyenne Bottoms (Kansas) Migratory Bird Refuge, and beginning of surveys thereof under a special appropriation of \$50,000.

Inauguration of a program of research on the relations of wild life to the forests, including their game, fur-bearing, and predacious inhabitants.

The placing of an order with an experienced collector in Greenland for the delivery in this country of an initial herd of 34 musk oxen for transportation to Alaska for restocking.

Participation in the International Fur Trade Exposition and Congress at Leipzig, Germany, under congressional authorization and appropriation for the purpose.

Extension of cooperative predatory-animal control to the Lake States at the request of Michigan, Wisconsin, and Minnesota, where wolves, coyotes, and bobcats have been destroying game and livestock.

Publication of a technical report on red squill as a raticide, which is making possible the preparation of a uniformly toxic product for rat control that does not seriously endanger livestock.

Reduction of the bag limits on ducks and geese, to begin with the fall season of 1930, as an immediately necessary measure for wild-fowl conservation, and its favorable reception by the people generally.

Imposition of a record fine upon a violator of the migratory bird treaty act—\$2,700 for killing 90 eider ducks, which the Federal law protects by a close season throughout the year.

Creation of a committee of five members of the United States Senate, all well known for their interest in wild life, to investigate and report on measures for the conservation and replacement of land and aquatic wild-animal life.

BUREAU PERSONNEL

No changes of importance were made in the organization or higher administrative positions of the bureau during the year. It is fitting, however, here to record the death of an ex-chief and retired member of the Biological Survey, the only break of this kind in the roll of the chiefs of the organization from the time of its establishment in 1885 to the present:

Henry Wetherbee Henshaw, who served as Chief of the Biological Survey from June 1, 1910, to December 1, 1916, died in Washington, after a prolonged illness, on August 1, 1930, one month after the close of the fiscal year on which this report is made. Mr. Henshaw, who was born March 3, 1850, had been a life-long ornithologist and was well known as an all-round naturalist. His outstanding contributions to the work of the Biological Survey were his emphasis on the economic side and his furthering of the popularization of scientific information regarding birds. The passage of the first Federal migratory-bird law (1913) occurred during his term of office, as did also the first administration by the Biological Survey of the Federal regulations for the protection of migratory birds. He was the author of many books and articles on ornithology, including contributions to the series of bulletins and yearbooks of the department.

RESEARCH ON THE HABITS AND RELATIONSHIPS OF WILD LIFE

COMPREHENSIVE DATA ESSENTIAL

Progress has been made during the year in the study of problems of geographic distribution, classification, life history, and migratory movements of birds and mammals, of natural life zones, and of ecological relationships. The increasing demand on the part of wild-life administrators, research workers, and the general public for scientifically ascertained information on matters affecting the

wild life of the country, in response to the steady growth of popular interest in wild life, accentuates the need for a vigorous prosecution of research work as a basis for a properly balanced program of wild-life administration.

The essential in wild-life research is reliable information regarding the habits, the diseases and parasites, the feeding preferences, the available food resources, the natural enemies, the reproductive cycle, and the relationships to humankind. Comprehensive data and sound interpretation are required if intelligent, far-sighted action is to be taken in efforts to improve the welfare of wild life, to control inordinate increase of numbers, or to restock depleted areas, and to make necessary adjustments of wild-life interests to agriculture, forestry, livestock production, and other associated economic uses of land and water areas.

The research program of the Biological Survey is being articulated more closely with the work of other Federal and State agencies and educational and research institutions and organizations, and its extensive collections of specimens and important files of records and literature are made freely available to properly accredited investigators throughout the country.

REGIONAL INVESTIGATIONS

As a result of a cooperative investigation carried on by the Biological Survey and the Kentucky Geological Survey, a report on the wild life of the Mammoth Cave region, including the caves and their approaches, was prepared and is now in course of publication by the State agency. A report on animal life of the Yellowstone National Park also was completed for outside publication and has now been issued.

RESEARCH ON BIRDS

Established lines of research in ornithology have been continued so that information may be readily available on the classification, distribution, migration, and life histories of birds, both for general use and for the program of research on the relationships of birds and other wild life to forestry production. About 75,000 records on these subjects have been carded during the year, and a considerable number of specimens added to the collection by field workers and voluntary contributors. Of more than 1,500 specimens identified for individual correspondents and for museums, some were referred to the Biological Survey because of difficulties in identification involving special research and comparison with types and series of specimens. The list of voluntary cooperators who observe and report on the general migratory movements of birds numbers more than 500, and 53 additional individuals have submitted reports on censuses of birds on selected areas.

LOCAL STUDIES

Financial assistance contributed by public-spirited cooperators made it possible to take steps toward publication of a comprehensive report on the birds of the State of Florida. This will make available the results of several years of field and laboratory investigations by members of the Biological Survey and many of its cooperators.

It will contain a history of the ornithology of the State, an account of the known bird population, including descriptions, life histories, and ranges, and ample illustrations in color.

Two field workers of the Biological Survey contributed a comprehensive report on the birds of the Portland (Oreg.) area, which was published during the year in the Pacific Coast Avifauna series of the Cooper Ornithological Club.

The birds of the Mississippi Valley region are being studied to obtain information supplementary to that already available regarding its bird population. Special attention is being given to birds now breeding on and in the vicinity of the Upper Mississippi River Wild Life and Fish Refuge as part of the program that has been inaugurated to make thorough biological studies of Federal game preserves and bird refuges.

BIOLOGICAL INVESTIGATIONS OF MIGRATORY BIRDS

Waterfowl censuses were continued this year as last, the reports averaging about 1,800 a month. To obtain voluntary cooperation and to investigate first-hand the waterfowl areas and conditions affecting the welfare of migratory game birds, field trips were made by representatives of the bureau to Alberta and southern British Columbia, to the Pacific Coast States, to Arizona, New Mexico, and Texas, and to important waterfowl areas of the Potomac River and Chesapeake Bay. These inspections, together with reports of co-operators and investigations by other members of the staff, developed much valuable information. After conference with Canadian officials a change was made in the method of gathering information from cooperative observers. Hereafter, instead of the monthly system of reports, quarterly reports will cover conditions observed during the winter, the spring and fall migrations, and the summer breeding period, to supplement field observations and reports by members of the employed personnel of the bureau.

BIRD-BANDING OPERATIONS

Banding operations have furnished increasingly valuable information regarding the migratory movements of waterfowl and other birds. The positive data obtained make it possible to determine and chart flight lanes between wintering and breeding grounds and their relation to resting and feeding areas. The resulting information will be exceedingly helpful in establishing refuges and in settling difficult questions of fact involved in the administration of the migratory bird treaty act.

The total number of ducks and geese banded up to the close of the fiscal year was 59,771, of which 27,724 were mallards, one of the most highly prized of game birds. Other important species banded in lesser numbers were black ducks, 8,387; pintails, 9,991; blue-winged teals, 2,362; lesser scaups, 2,079; green-winged teals, 2,045; and redheads, ringnecks, and baldpates, more than 1,000 each. Localities where 100 or more waterfowl have been banded have increased to 67. They are well distributed from Alaska and southern Canada to southern California and the Gulf of Mexico. Sportsmen have cooperated heartily in reporting on the banded ducks in their bags.

Cooperating banders who operate trapping stations of all types now number about 1,750. The number of bands purchased by the bureau and issued during the year totaled 272,000, and birds banded numbered 182,263. The return records received are estimated at 10,000, representing a 33 per cent growth over the previous year. Leading research and educational institutions recognizing the scientific value of the work are participating increasingly in the banding operations. Bird-banding research is being more and more stressed in the organization of cooperative projects, and at least a dozen major trapping and banding stations have been established at universities and colleges from Maine to California.

To afford information on and to illustrate tested apparatus and technic, a *Manual for Bird Banders* (Miscellaneous Publication No. 58) was issued during the year. This has proved a distinct stimulus to more effective work and to application of banding to special research problems and life-history work. Two other official publications on bird banding also were issued—an article in the 1930 Yearbook, *Migratory Status of Mourning Doves is Proved by Banding*, and a circular (No. 118) on a method suggested for calculating the abundance of waterfowl on the basis of returns from banded birds. Better coordination of the efforts of cooperators should result from the combination of the Northeastern, Eastern, and Inland Bird Banding Associations in support of a new quarterly journal, *Bird Banding*, formerly issued as the *Bulletin of the Northeastern Bird Banding Association*. The Western Association continues to issue its own mimeographed quarterly, *News from the Bird Banders*.

RESEARCH ON MAMMALS

INVESTIGATIONS AND REPORTS

More extended field work was conducted than has been possible for several years, and many places throughout the country have yielded specimens of mammals and data regarding their distribution, habits, and relationships. Specimens numbering more than 1,500 were identified for institutions and individuals representing 22 States and 1 foreign country, and included many studies to determine the kinds of animals involved in economic problems. Interchange of materials needed for special study comprised 490 specimens borrowed from 7 institutions and 290 loaned to 11 institutions in 8 States and 1 foreign country. Investigators thus provided with material for work on research problems represented 16 States, Alaska, and 3 foreign countries.

A study of the ranges and relationships of chipmunks undertaken some years ago was recently completed, and the results embodied in a report issued in November as *North American Fauna* No. 52. A full account of the life history and economic status of the grasshopper mice also was issued in November as a technical bulletin (No. 145) of the department. In cooperation with the State College of Washington, a report was published by that institution in December on a provisional list of land mammals of that State, the senior author being a biologist of this bureau. The information presented was based primarily on specimens and notes acquired by the Biological Survey and cooperating institutions in work con-

ducted under the field leadership of the senior author. Progress also was made on studies of the mammals of Lower California, and a taxonomic revision of the group of the mountain lions was brought nearly to completion.

Studies were made of the game resources of the Southwestern region, including deer, antelope, mountain sheep, and various upland game birds. Attention also was given to the economic relationships of predatory animals and to species of value as fur producers.

DEER INVESTIGATIONS

Cooperative studies of deer with the State Game Commission of Pennsylvania were continued to ascertain the cause of lowered vitality and losses among these valuable game animals. The fact-finding committee appointed by the commission, which by request included a representative of the Biological Survey, who served as chairman, has completed a series of reports based on field and laboratory investigations, including feeding studies. Much new and important information was obtained as a result of this work, and the reports are now in the hands of the commission for publication.

The condition of deer at many other points has also been studied by representatives of the bureau in gathering data regarding their abundance, availability of food supplies, and their diseases and parasites. Further study was made of the deer herds on the Kaibab Plateau, Ariz., their available food resources, their range requirements, and the effects of their browsing on the forest. Methods of hunting to reduce excessive numbers, and of capture and transportation for restocking depleted areas, also received attention.

ELK IN WYOMING

Studies of the southern herd of elk in the vicinity of Jackson Hole, Wyo., have been continued and results of increasing value obtained. The studies include details of life history of the elk, the effect on them of predatory animals, their range and feeding requirements, and other factors affecting their well-being. When it was found that their feeding upon certain plants was responsible for lesions inducing necrotic stomatitis and causing severe losses, experimental studies were undertaken in cooperation with the Bureau of Plant Industry to determine means of eliminating such plants or of harvesting them at a season when not injurious. Assistance in the study of disease conditions was given by the Bureau of Animal Industry. An article on epizootic diseases of elk, prepared by the field specialist of the Bureau of Biological Survey and published in the *Journal of Mammalogy*, in May, 1930, summarized the important results obtained.

Upon request a report on the work was submitted to the Elk Commission. Cooperation has been continued also with the Forest Service of this department, the National Park Service of the Department of the Interior, and the State Game Commission of Montana in studies of the northern Yellowstone herd. At the request of the Yellowstone Park Boundary Commission, a special study, under the leadership of a bureau representative, and participated in

by the Forest Service, the State Game Commission of Wyoming, and the National Park Service, was made of game conditions in the upper Yellowstone-Thorofare region, with particular reference to elk and moose and their migratory movements.

Detailed studies also are being made of the plants upon which the elk feed, and of those they consistently avoid. The experiment station of the University of Wyoming is assisting in chemical analyses to determine nutritive properties and possible poisonous or other deleterious qualities of these plants.

Careful studies also are being made in the Jackson Hole region of the moose, deer, and antelope and their general ecological relationships.

RODENT ECOLOGY

Interest in wild-life research in the Southwest is increasing steadily as the value of the work conducted on rodents and other small mammals during the past several years is coming to be recognized. There has been a notable strengthening of the work with cooperating institutions, and further expansion is in prospect. A recent conference was held to consider the unification of research activities along these lines by the Universities of Arizona and New Mexico and the agricultural colleges and experiment stations of these States, the Forest Service, the Bureau of Animal Industry, the Bureau of Entomology, and the Bureau of Biological Survey of this department, the National Park Service and the Bureau of Indian Affairs of the Department of the Interior, the Carnegie Institution of Washington, including its desert laboratory near Tucson, Ariz., and the Game and Fish Commissions of New Mexico and Arizona.

Studies have been continued on experimental inclosures on the Santa Rita range reserve and at a number of representative points in northern Arizona of kangaroo rats, rabbits, prairie dogs, porcupines, and other rodents in relation to range forage production, to erosion and soil working, to natural seeding, and to planted seeds of forest trees.

Reports were prepared for publication by the field representative of this bureau working on the project summarizing some of the important data and conclusions on the following subjects: Ecology and life history of the porcupine as related to the forests of the Southwestern United States; methods of determining the effect of rodents on the range; and rodents as factors in soil formation and modification.

BIOLOGICAL RESEARCH IN FOREST WILD LIFE

Research by the Biological Survey on the relation of birds, mammals, and other vertebrates to forest production was begun during this year in accordance with provisions of the recently enacted McSweeney-McNary forestry research legislation. A very large amount of work in this general field had been done previously by naturalists of this bureau, and the results afford a good basis for starting the new work. In expanding the field two additional biologists were added to the staff to devote their entire time to experiments and investigations relating to animal life on forested areas, including geographic distribution and observations on life histories and general

habits. Their studies cover the seasonal occurrence and activities of birds and their migratory movements with direct reference to their beneficial or harmful relations to the forest and the value of certain species of birds and mammals as game. Facts that operate to increase or to reduce wild-life population are noted, as well as the natural and artificial conditions necessary to maintain numbers sufficient for recreational purposes, and to provide profitable use of forest lands for game production without undue interference with the seeding, growth, and utilization of trees; forage, and other forest products. This includes study of the relationships to livestock of big-game animals, such as deer, elk, and moose, and means of increasing the game-carrying capacity without detriment to legitimate livestock interests.

Experimental plots have been established at favorable points on the forests to determine the effect of rodents and other animals on growing plants and in distributing or destroying seeds of forest trees and forage plants either in natural seeding or in planted areas. The relation of denuding and burrowing species to soil formation and working and to water run-off and erosion constitutes an important feature of the investigations.

Studies are made also of the present abundance of species valuable as fur producers, their source of food supply, and their relation to game and other valuable or harmless wild life of the forest. Exact information on the place of the fur bearer as a factor in forest economy, from the viewpoint of both possible beneficial and harmful qualities, is essential as a basis for administration and determination of the maximum profitable use of land and water areas in the forests.

BIOLOGICAL INVESTIGATIONS OF INJURIOUS ANIMALS

The biological investigations of injurious animals have been concerned for the most part with identifications for the benefit of bureau representatives and of cooperators engaged in rodent and predatory-animal control. Exact information regarding the kinds of animals actually responsible for damage to crops or livestock is essential in determining the control measures appropriate, and in intelligently planning efficient measures for affording relief to producers. Certain identifications help to safeguard species that occur in the regions involved but are not responsible for damage observed, or whose habits and relationships are predominantly beneficial. Information was furnished regarding the geographic distribution, habits, and life histories of species involved in control operations or about which questions arose, and included the preparation of maps of known ranges. The large reference collections and the extensive files of information assembled from field and laboratory studies and from published sources are indispensable and are constantly used by specialists of the bureau in making identifications and compiling information requested.

EXPERIMENTS WITH MOUNTAIN SHEEP AND MUSK OXEN

In cooperation with the Alaska Agricultural College and School of Mines experiments have been made near Fairbanks in the domestication of mountain sheep. Five animals were obtained from the Mount McKinley National Park in the summer of 1929, and these tamed readily and adapted themselves promptly to handling and feeding.

The appropriation for the fiscal year 1931 provides funds to be used in obtaining and establishing at the reindeer experiment station a herd of musk oxen with a view to their reintroduction into Alaska. They were formerly native to the Territory but were exterminated there many years ago. Before the close of the fiscal year an order had been placed with an experienced collector for the delivery of 34 head of these animals from Greenland. Additional land for their use at the reindeer experiment station has been set aside by Executive order.

REINDEER INDUSTRY IN ALASKA

Problems involved in the production of reindeer in Alaska have had the full benefit of research work. Crossbreeding experiments with reindeer and caribou have progressed during the year. Reports based on a study of the reindeer herd on the Nunivak Island Reservation show clearly an increase in size and improved conformation in the crossbred animals, resulting from the introduction of caribou blood, and increased vigor and ability to rustle for food and withstand the rigorous climatic conditions. Experiments are being conducted at the reindeer experiment station near Fairbanks to determine the proportion of interbreeding that gives the most satisfactory results preliminary to the selection of improved breeding stock for introduction into the Alaskan herds.

The steady growth of the reindeer herds has emphasized the need for efficient herd and range management. Practical recommendations are made on the basis of investigations of the extent and character of the range, and of grazing practices essential to maintenance of continuous and profitable yield, for the benefit of those engaged in the industry and of Territorial officials responsible for land allotments and native herd supervision. At the request of the governor of the Territory, reindeer-production experts of the Biological Survey have been serving on an advisory committee engaged in working out plans and policies relating to grazing allotments and herd management.

Definite advance has been registered in studies of the nutritive value of the various lichens, browse, and other natural forage, and of grain, hay, and root crops produced by farmers in Alaska. In these studies carefully conducted feeding experiments are made and the condition of the animals is noted. In cooperation with the Bureau of Animal Industry thorough biochemical and vitamin studies are made of the feeds used and of the waste products of metabolism. Similar studies also are made of the chemical and physical character of the reindeer meat and its nutritive properties. In cooperation with the Bureau of Home Economics a leaflet (No. 48) was issued in November, based on studies of the palatability of reindeer meat and of the methods of preparation that enhance its attractiveness as a food product.

Investigations of the life history and habits of warble flies have been prosecuted in cooperation with the Territory of Alaska, and the Bureau of Entomology of the department, to determine practical methods of preventing their injury to reindeer. The flies and their larvae cause much distress and disturbance to the animals and greatly reduce the value of the hides for leather and garment manufacture.

Nose flies and other insect pests of reindeer also are being studied. The Bureau of Entomology has given valuable cooperation by detailing competent entomologists to undertake the fundamental studies of the biology of these parasites and of repressive measures. The conduct of these studies is very difficult because of the exigencies of reindeer handling on the vast Alaskan ranges.

Representatives of the Biological Survey in Alaska have aided Canadian officials and investigators in their efforts to determine the suitability of great areas of range land in northern Canada for reindeer production. Upon completion of a contract with Alaskan producers for the purchase by the Canadian Government of a herd of 3,000 reindeer and their delivery at an agreed time and place, arrangements were made for a representative of the Biological Survey to study practical features and difficulties encountered in starting the long overland drive. The observations made will be of value also in Alaska in connection with the transfer of herds to the vast unoccupied range lands of the interior, or for fattening and slaughter at points favorable for shipment and for the disposal of meat and other products.

A circular (No. 82), entitled "Improved Reindeer Handling," was issued during the year, to make available to the industry the results of investigations thus far conducted and to detail in a practical way the solution of problems in herd management, corralling, marking, recording as to ownership, feeding, breeding, slaughter, use of reindeer as draft animals, range use, and deleterious results of range fires and parasitic infestation.

ECONOMIC INVESTIGATIONS OF WILD LIFE

LABORATORY STUDIES

FOOD OF BIRDS

Although three employees usually engaged in the study of the food of birds were detailed to other lines of work, employment of additional assistants made possible some progress on standing lines of investigation, which latterly had to be more or less neglected, notably the study of the food habits of the diving ducks and of the hawks and owls. Examinations were completed of stomachs collected in Florida during an investigation of birds in relation to the insect pests of celery. Information resulting from this work as well as from similar studies made in previous years will be combined for final publication with findings of an investigator in the Bureau of Entomology.

Special investigations as usual were a feature of the work, and included examinations of the stomachs of prairie chickens and sharp-tailed grouse from Wisconsin, as part of a general study of the life histories of these birds; a study of woodpeckers and nighthawks from Montana, to learn their status as enemies of the mountain pine beetle; of butcher birds (shrikes) from California, with respect to alleged destructiveness of other birds; of fish-eating birds from Montana; and of a variety of species from Florida, of which knowledge of the feeding habits is meager.

FOOD OF OTHER ANIMALS

A considerable number of examinations of mammal stomachs were made, principally of moles, collected to learn their relation to the bulb industry on the Pacific coast; of muskrats from Atlantic coast marshes, to increase information on their food habits; and of predatory mammals, to learn whether their popular classification as "vermin" is justifiable. A few analyses of reptile and amphibian stomachs were made, and a report on the Habits and Economic Importance of Alligators (Technical Bulletin 147) was published. The maintenance of reference collections was a special feature of the work, the seed collection in particular being brought up to date and found to comprise more than 5,000 samples of seeds, representing 3,247 species of 1,112 genera.

FIELD INVESTIGATIONS

ECONOMIC ORNITHOLOGY

On the experimental farm of the department in Arlington County, Va., are sample plots of grasses of interest in connection with the maintenance of golf courses. These are used for many experimental purposes, and last spring it was noted that birds were making holes in them, one species, the European starling, sometimes to an objectionable extent. A study of the situation was made, and the results showed definitely that cutworms, which were abundant in the turf, were the principal attraction to the birds. In all probability the cutworms can be greatly reduced or even exterminated by the use of proper insecticides. When this is accomplished, damage by birds undoubtedly will cease. Similar cases have been heard from on golf courses in other sections. The first reaction is to shoot the birds simply to stop the digging of holes; obviously this procedure does not cure the real trouble—damage by destructive insects—which the work of the birds tends to control.

Studies of objectionable starling roosts were made in the District of Columbia, and a case of bird mortality was investigated in which the cause was found to be poisoning operations on the part of persons unknown. A brief publication on English Sparrow Control (Leaflet 61) was published during the year.

The cooperative project of attracting birds to the experimental chestnut orchard of the Bureau of Plant Industry, at Bell, Md., was continued and a further increase achieved in the number of broods produced to the acre. During the four years of the investigation this figure has risen steadily year by year, as follows: 6.8, 16, 18.5, and 25.4. These data apply only to birds occupying houses supplied for them and do not include birds nesting in trees.

Preparatory to a hearing before the Rivers and Harbors Committee of the House of Representatives, an inspection of the Back Bay-Currituck Sound region of Virginia and North Carolina was made in December. This was the eighth trip made to that region by the same investigator for the study of duck-food conditions, besides inspections by other representatives of the bureau. The damage to duck-food plants in that area from salt and sewage contamination coming through the Albemarle and Chesapeake Canal has continued

until vegetation is found to be almost entirely destroyed over about half the entire area of these two bodies of water, a total of about 300 square miles. The diminution in the food supply has had the inevitable result of reducing the numbers of wild fowl visiting the region, and there are not now a hundred wild geese or swans where formerly there were a thousand, and not one duck where there were ten thousand during the time when the food supply for the birds was at its best. The long campaign that has been made for alleviation of this trouble has been crowned with success, as an authorization item for replacing the guard lock in the Albemarle and Chesapeake Canal was included in the rivers and harbors bill passed in the last session of Congress. It is confidently expected that restoration of this lock will result in gradual recovery of the waters from their polluted condition.

Brief studies were made of the condition of wild-duck food plants at three other localities in Virginia, and measures for improvement suggested. In response to complaints that birds were being killed by weed-spraying operations along certain southern railroads, an investigation was made and it was found that little if any damage was being done.

The radio was utilized during the year to broadcast information on the economic status of commonly known birds. Over a nationwide chain of stations officials of the Biological Survey gave short addresses on how birds help the farmer and on the profit and loss sides of wild life in general. A similar broadcasting of information on the economic status of wild life was given over the same chain of radio stations in a symposium on poisonous pests of campers, the Biological Survey's contribution relating to poisonous snakes. Addresses by radio have resulted in increased demands for publications of the bureau on the subjects thus presented.

FOOD HABITS OF MAMMALS

The relation of rodents and moles to the bulb industry on the Pacific coast has been made the subject of a long-continued investigation, the results of which have been incorporated in a manuscript for a farmers' bulletin. All classes of flowering bulbs commonly grown on the Pacific coast, with the exception of narcissus, are more or less severely damaged, but control measures are found practicable and will be recommended in the bulletin.

The study of the relation of rodents to reforestation in the Pacific Northwest has been continued; and material has been collected to demonstrate the food habits of the hair seal, an animal upon which, because of its alleged destruction of salmon, bounties are being paid. Reports made possible by the examination of this material should throw a clearer light on the economic status of these animals.

There was published, in August, a Farmers' Bulletin (No. 1598), reporting field investigations in the Pacific Northwest and detailing facts in the life history, habits, economic status, and measures recommended for the control of mountain beavers (genus *Aplodontia*), a group of rodents, formerly unobjectionable economically, that in certain areas has become destructive of crops.

ECONOMIC INVESTIGATIONS OF MIGRATORY BIRDS

DAMAGE BY MIGRATORY BIRDS

Some of the work referred to under the food-habits project, both in the way of established lines of work and of special examinations, related to birds protected by the migratory bird treaty act. It was necessary to give attention to some cases of damage by migratory birds and to recommend slight local alterations in the protected status of a few. The principal work of the year, however, was a continuation of the study of maladies of wild fowl.

To counteract certain unauthorized but widespread claims that swans and crows were so destructive as to warrant general control measures, the bureau issued statements last fall to the press, which were widely published, showing that swans do not destroy unduly the food plants of other waterfowl, including valuable wild ducks; and that the crow problem is for the most part local, by reason of which its proper solution is local and not through campaigns of general extermination. These statements were based upon thorough scientific investigations conducted both at the time, for the purpose of answering the charges made against the birds, and at earlier dates.

DUCK MALADY IN THE WEST

Study of the "alkali sickness" of waterfowl, resumed in June, 1929, was continued throughout the present fiscal year. Field and laboratory work was conducted in southern Oregon and northern California, with laboratory studies and other research work on various aspects of the problem at Washington, D. C. Late in June, 1930, the bureau investigator again left for the West to carry on another summer's field work.

Since 1918, when the Biological Survey published the results of its studies carried on in 1914, 1915, and 1916, alkali sickness has been of frequent recurrence, not only on the marshes adjacent to Great Salt Lake, Utah, where the earlier studies were made, but also at other points in Western States and in certain Canadian Provinces. Points in California, Oregon, Idaho, Montana, Nebraska, North Dakota, South Dakota, Utah, Texas, and the Canadian Provinces of Alberta and Saskatchewan have been the scenes of outbreaks that appear to be similar to the alkali sickness originally studied in Utah. Mortality among waterfowl at a few isolated spots in Arizona, New Mexico, and Kansas also may have been due to the same cause; and even from the State of Durango, Mexico, reports of dying waterfowl have come closely similar to those emanating from our own West.

The great diversity of these areas, especially with respect to the character and degree of salt content of the waters frequented by the sick birds, is one important reason for reopening the study of duck mortality. At some of the localities the entrance of factors other than those found to be causative agents under the highly saline and more or less uniform conditions surrounding Great Salt Lake seemed plausible and even likely. The Klamath region of southern Oregon and the adjacent area about Tule Lake, Calif., were chosen as a field of operations, not only because of the frequent occurrence

of the malady there, but also since the region possesses a variety of bodies of water and marsh areas, some of which are more or less regularly scenes of duck mortality, while others in the same general vicinity are markedly free of the trouble. A laboratory established at Klamath Falls, Oreg., served as a base from which all the places where disease was likely to occur could be reached, and provided facilities for the experimental feeding of healthy birds and for the recovery of sick ones.

The season's field work included the gathering of data on such pertinent factors as changes in water level, temperatures, and precipitation; the collection of water, soil, and encrusted alkali samples from diseased and disease-free areas for subsequent chemical analyses; observations on the growth and subsequent decay of algae in their possible relations to the malady; and a daily watch on the flights, abundance, and feeding habits of healthy birds, as well as the keeping of detailed notes on the number of sick birds encountered in the course of three local outbreaks.

Experimental work involved the feeding to healthy wild ducks of salts in the various concentrations and combinations commonly found in the alkaline waters of the area, with the object of noting reactions thereto and of producing if possible, a condition similar to that brought about by the duck sickness. Other experiments also were conducted along bacteriological lines. Through cooperation with the Bureau of Animal Industry, whereby a specialist was detailed to the laboratory for a part of the summer, the possibility of parasites as causal factors was studied. In all these endeavors the results obtained were essentially negative. Chemical analysis of the waters collected also failed to reveal any constant factor as the causative agent.

During the winter the history of the malady in this country was studied. Experiments also were conducted to disclose the symptoms produced in ducks by certain gases that might have a bearing on the problem, as well as to note the effects of salts not previously experimented with; but thus far the results are either negative or inconclusive.

LEAD POISONING IN LOUISIANA

Late in the winter, investigation was made of mortality among ducks in Vermilion Parish, La. Lead poisoning, a deadly affliction that besets waterfowl in areas that long have been used as hunting grounds, was found to be the cause. Although the extent of the mortality was by no means so great as in former years, the outbreak served again to call attention to the ever-present menace of lead shot deposited on favorite shooting grounds. This shot no doubt persists for many years, buried on mud flats or submerged on lake bottoms. The hapless duck or marsh bird swallowing even a few pellets of shot along with other hard objects taken as grinding material usually is doomed. The poisoning process is a lingering one, death coming after days and even weeks of physical decline.

SURVEYS OF FOOD RESOURCES OF REFUGE AREAS

To complete a reconnaissance of sites proposed for Federal migratory-bird refuges, investigations of their biological fitness

were conducted throughout the vegetative season, and inspection of sites was made in every State of the Union. The total number of projects surveyed from the food-resource standpoint, including about a month's work in the preceding fiscal year, was 189; the total acreage was in excess of 3,700,000. According to their suitability for refuge purposes, these projects were rated as follows: Most highly recommended, 33; less highly recommended, 56; not recommended, 100.

In addition to work on prospective refuge areas, considerable attention was given to the proposed plan for the improvement of navigation on the upper Mississippi, which, if carried out, would vitally affect the Upper Mississippi River Wild Life and Fish Refuge. The Biological Survey was represented at informal conferences on the subject in Washington, and at a formal hearing before the United States Board of Army Engineers in St. Louis. When the possibilities of damage to vegetation on this refuge and consequently to its wild life were pointed out, it was apparent that there was a sincere desire to avoid this, and that in selecting the type of dams to be used in stabilizing water levels, the interests of wild life would be taken into consideration.

COOPERATIVE INVESTIGATIONS IN GAME-BIRD PROPAGATION

The final report on the cooperative quail investigation, the field work for which was completed last year, was prepared, presented to the committee on the investigation, and placed in the hands of a publisher. It will be published for sale only, under the direction of the committee that financed the investigation, and will make a book of more than 600 pages. It will be the most complete account published in the United States of the life history of any game bird and will compare favorably with any that have been produced elsewhere.

The success of the cooperative quail investigation has inspired other similar studies, a number of which are being carried on under fellowship arrangement through cooperation of State universities, the Sporting Arms and Ammunition Manufacturers' Institute, and the Bureau of Biological Survey. The studies already under way are concerned with the Hungarian partridge in Michigan, the bobwhite in Wisconsin, and the ruffed grouse in Minnesota. Arrangements were completed during the year, although the research was not actually begun, for a study of Gambel's quail in the Southwest, with the headquarters of the investigation at the University of Arizona. Cooperation of the Biological Survey in these studies has consisted of assistance in the selection of fellows, in planning and organizing their programs, and assisting with the field work itself for short periods at irregular intervals.

Somewhat similar work included cooperation in planning the program now being undertaken by the New York State Conservation Department for investigation of the ruffed grouse; and inspection of field-trial grounds and other areas in various States, with recommendations for maintaining their maximum population of game birds. A few visits were made to game farms for the purpose of advising as to sanitary and other features of the work and of studying the latest developments in game-bird propagation.

Two 'farmers' bulletins on rearing game birds were published during the year, one (No. 1612) on Propagation of Aquatic Game Birds, and the other (No. 1613) on Propagation of Upland Game Birds; and to supplement correspondence a mimeographed leaflet (Bi-1064) listing dealers in quail-food plants was issued.

Miscellaneous research in the game-bird field resulted in the publication in November of a circular (No. 96) on foreign game birds suitable for naturalizing in the United States. Both the desirability and the dangers of experimental plantings of exotic species are discussed in the new publication, and an annotated list of species suitable for various regions is presented.

INVESTIGATIONS IN FUR-ANIMAL PROPAGATION

PRODUCTION OF FUR-BEARING ANIMALS

Since the United States is the leading fur-producing as well as fur-consuming country in the world, there has been a constantly increasing demand for scientific information on the conservation, propagation, and utilization of fur animals from interested individuals both in this country and abroad. Extensive studies are being made of all factors involved in the production of fur animals, not only in the wild but under controlled conditions. Cooperative relations have been entered into with the Carnegie Institution of Washington for the purpose of undertaking a comprehensive study of the embryology and physiology of reproduction of the various fur bearers, with the special object of establishing their normal breeding and gestation periods, and other forms of research are carried out in cooperation with the Universities of Minnesota and Southern California. In Alaska the Territorial veterinarian has been appointed as a collaborator of this bureau, and this arrangement will aid in correlating findings on fur animals in that Territory with those resulting from research, experiments, and observations in the States.

The muskrat is recognized as the leading fur producer under natural conditions, and special attention is being given to investigations of this animal in three distinct types of country—the Atlantic coast region, the Gulf coast region, and the inland lake and river districts. It has too frequently been the practice to take muskrats from marshes in a wasteful manner, overtrapping being the rule in many marshes, and operations not being limited to the season when the pelts are of greatest value. One purpose of the research on these animals as directed by the bureau is to determine the time when their pelts reach maximum primeness and the conditions that influence development to this state. Studies on the food and breeding habits of muskrats have been begun, and investigations are in progress with respect to the influence of changes in water levels on the rate of reproduction. It has been found that comparatively few muskrat marshes lend themselves at reasonable expense to a mechanical control of the water by means of dams and canals. Attempts to raise muskrats under closely controlled conditions have been tried by a variety of methods, though with negative results, and it appears that the fur trade must continue to look to the natural marsh areas for muskrat furs. This means increased atten-

tion to the conservation of marshlands. To bring this fact before the public and to present the chief considerations in the conservation and propagation of these valuable fur bearers, a mimeographed leaflet (Bi-1060), *Raising Muskrats*, was issued during the year.

Investigations indicate that it would be impracticable profitably to raise certain other important fur bearers in small pens under controlled conditions, notably raccoons, beavers, and opossums. Their maintenance will have to depend on a flexible adjustment of hunting and trapping laws, in order that they may not be exterminated or depleted to the point where trapping is not profitable. In another group of fur animals, however, the pelts of which are of somewhat higher value, the species seem to be suitable for pen raising. It seems possible to maintain badgers, fitches, martens, fishers, and minks in captivity under such conditions that ultimately a profit may be made from the sale of skins. Success is dependent upon their attaining a sufficiently high rate of reproduction in captivity. Through the kindness of an individual interested in the experimental work conducted by the bureau, a pair of German fitches were donated to the Biological Survey for investigations on their care, feeding, and breeding habits.

If reasonable protection is given to such fur bearers as live only in the wild, they can be encouraged to utilize extensive areas of otherwise unproductive land. The importance of such protection was stressed in the annual digest of the fur laws of the respective States (Farmers' Bulletin No. 1618).

FUR FARMING

That furs of certain kinds can be produced satisfactorily on farms has been demonstrated by the fact that practically all silver-fox pelts reaching the market are now ranch raised. Though silver foxes are not being produced in the temperate and warmer parts of the United States, it is probable that other fur bearers may be found to be suitable for pen raising in such sections. Breeding stock can now be purchased at prices more nearly commensurate with the actual worth of the animals than heretofore. It is estimated that in this country \$50,000,000 is invested in fur farming.

Despite adverse conditions in the fur trade during the past year, fur farming has fully held its own, and many fur farms operating on the pelt basis have shown substantial net earnings. Prices of raw pelts were lower than for several years past, but it is doubtful whether the drop was comparable with that of other raw materials for wearing apparel. Though some fur farms went out of business, many new ones were established and a number of the older ones enlarged.

Just what effect the drop in fur prices will have on the extent of the wild fur take can not be foretold, though possibly protective measures may be more easily enforced. The acquisition by large companies of extensive tracts of land supporting many fur animals for the purpose of commercial trapping also is aiding in conservation measures, since owners of such areas have large sums of money invested and naturally are anxious to lend every aid in improving their holdings.

DISEASES OF FUR ANIMALS

Studies of diseases of fur animals have been continued in cooperation with the University of Minnesota, at the university as well as on fur farms where outbreaks have occurred. Attempts made under practical ranch conditions to immunize foxes by means of serums against some of the more commonly encountered diseases have met with a fair degree of success. Before such products can be offered to the public for general use, however, the tests must be carried further and a greater certainty of protection against disease developed.

Besides the more commonly encountered maladies—fox paratyphoid and epizootic fox encephalitis—on a number of fox farms other sporadic infectious diseases have made their appearance. Though these have not as yet received complete study, it has been ascertained definitely that epizootic fox encephalitis and dog distemper are distinct diseases.

A motion-picture film was released in July, 1929, depicting the symptoms and pathology of fox encephalitis. This film was made at intervals during the past two years in cooperation with the University of Minnesota at fox farms and elsewhere when the disease made its appearance. It will be of special value to conventions of veterinarians and fox breeders.

To learn ways of preventing losses from diseases in rabbitries, and to study their cause and methods of control, a cooperative working agreement was entered into in August, 1929, between this bureau and the University of Southern California.

FUR-ANIMAL EXPERIMENT STATION

The major activity at the fur-animal experiment station, maintained by the Bureau of Biological Survey at Saratoga Springs, N. Y., is investigations on silver and cross foxes, and during the year several pairs of badgers and martens also have been under observation there. The process of discovering new facts affecting the crossing of various strains of silver and red foxes is exceedingly slow. Inadequacy of facilities, including lack of a sufficient number of breeding animals, has retarded these studies. Along with the breeding experiments, extended tests in the control of parasites of fur animals have been carried on, as well as a study of the problems of general hygiene. A mimeographed leaflet (Bi-1053), *Ear Mange in Foxes: Its Treatment and Eradication*, was issued, and a printed leaflet (No. 47), *Hygiene in Fox Farming*, was published during the year for the guidance of fox farmers. Of special interest to those striving for economical production of foxes for fur is a mimeographed leaflet (Bi-990), *A Comparison of Feed Costs with Pelt Values of Silver Foxes*, which has been issued recently in revised form.

Knowledge of the care and breeding habits of badgers is as yet incomplete, but for the purpose of supplying the available information to the many inquirers on the subject a mimeographed leaflet (Bi-1059), *Raising Badgers in Captivity*, was issued during the year.

The birth of a litter of four martens in April confirms the findings of previous years on the gestation period in this species. A résumé

of the knowledge gained at the fur-animal experiment station on the reproduction of these animals, as well as of observations by other investigators, has been made available in a circular (No. 107), entitled "The Normal Breeding Season and Gestation Period of Martens."

In cooperation with the American Fox Breeders' Association and the New York State Fox Breeders' Association, the third day of their convention and summer school in September was given over to a visit to the fur-animal experiment station, where field-day exercises were held. Representatives of the department explained the purposes and work of the station, and during a tour of inspection the visitors had full opportunity to gain first-hand information about breeding experiments with red foxes, purebred silver foxes, martens, and other fur bearers, construction of pens and other fixtures, the use of instruments in treatment of diseased animals, and feeding experiments. The station is kept open to the public on Wednesdays and Sundays from June 1 to December 1, between the hours of 10 and 4.

RABBIT EXPERIMENT STATION

The main purpose of the rabbit experiment station, maintained by the bureau at Fontana, Calif., is to investigate improved methods suggested for raising domestic rabbits for food and fur. Changing conditions in this rapidly developing industry require an increased series of experimental tests on the nutrition, housing, and breeding of rabbits. Feeding studies are being made with a wide variety of suitable foods native to various parts of the country. Information thus far developed is contained in a recently issued mimeographed leaflet (Bi-1066), *Suggestions for Beginners in Rabbit Raising*. This leaflet likewise presents other important information for prospective investors in the rabbit-raising industry. A full description of the new station, its equipment, and methods of research was published in the 1930 Yearbook of Agriculture.

One of the prime essentials to making rabbit raising successful is the development of a market for the meat, the sale of which provides the principal source of income for the average commercial rabbitry. The Bureau of Home Economics, with the cooperation of the Bureau of Biological Survey, had in press at the close of the year a leaflet (No. 66), entitled "Rabbit Recipes," prepared to give helpful suggestions to consumers on the best methods of preparing this commodity for the table.

The matter of construction of suitable buildings and hutches for rabbits in diverse parts of the country is receiving considerable attention. A leaflet (No. 15), *Rabbit-House Construction*, has been revised to suit modern demands, in cooperation with the Bureau of Public Roads. One function of the experiment station is to develop a type of hutch construction that will minimize the work of caring for stock and be of such design that sanitation will be maintained easily. The latest findings are presented in the revised leaflet.

In addition to its general dissemination of information on rabbit production in bulletins, leaflets, and radio addresses, the bureau has utilized the exhibit method on occasion during the year for depicting rabbit raising at fairs and conventions in Western and Southwestern States, the region where the industry is at present most flourishing.

INTERNATIONAL FUR-TRADE EXPOSITION

By special congressional authorization it has been made possible for the United States Government to participate in the International Fur Trade Exposition and Congress held in Leipzig, Germany, from June 1 to September 30, 1930. Frank G. Ashbrook, in charge of the division of fur resources of this bureau, was appointed commissioner general to represent the United States. An exhibit representing various phases of the fur industry in the United States was prepared in the office of exhibits of this department. The information and material were furnished in cooperation with this bureau and the Bureaus of Fisheries and of Foreign and Domestic Commerce of the Department of Commerce. The purpose of the exhibit is to depict all aspects of the fur industry in this country so that interested individuals and organizations from other countries may be better informed with respect to the sources of the supply of furs as well as on the nature and extent of the commercial manufacture of raw furs into finished wearing apparel as conducted in the United States.

The exhibits display fur animals native to this country in their natural habitat, as well as scenes and operations on fur farms, and these are supplemented by motion pictures, lantern slides, transparencies, and charts, together with a special bulletin in English and German editions, discussing all phases of the fur industry. Visitors from foreign countries to this exhibit were encouraged to cooperate with this country in measures for the conservation and production of furs and fur animals, and for such utilization as the condition of the native stocks warrants.

RESEARCH IN CONTROL METHODS

To control the various species of vertebrate animal pests calls for a broad program of investigation so that field workers may apply up-to-date methods that provide essential safeguards. Such predatory animals as coyotes, wolves, bobcats, and mountain lions, and an occasional stock-killing bear, cause heavy monetary losses in live-stock and destroy much valuable game every year. Prairie dogs, ground squirrels, rabbits, porcupines, woodchucks, rats, mice, or other rodents destructive to forage, growing crops, stored hay, and foodstuffs are found in all parts of the United States. Occasionally, also, gregarious species of birds become economically injurious—notably, in some localities, crows, magpies, and starlings. Research work in methods of control is conducted in a laboratory of the Biological Survey at Denver, Colo., and in field tests by a staff of technical men working in conjunction with control operators, and in the case of most birds, by economic ornithologists detailed from the Washington office.

During the past year the field laboratory was called upon to develop a means of combating the difficulty that had been experienced in the West in controlling the activities of rodents, including rabbits, ground squirrels, and prairie dogs, which in some localities were feeding on native plants that had a tannic-acid content sufficiently high to counteract the effect of ingested strychnine. Control operations at certain times of the year were thus made extremely difficult.

In other cases changes in control methods had to be worked out on rodent-infested lands that had been treated for several years with strychnine-coated grains, where the survivors had developed a distaste for them and something of an immunity to their usual action.

The bureau is constantly striving to develop methods that will prove more effective against predators and rodents and at the same time be less harmful to other forms of wild life. Though the gallinaceous group of birds, such as quail, grouse, and domestic chickens, are practically immune to the usual effect of strychnine, other forms of bird life are susceptible. It has been demonstrated, however, that grain baits may be efficiently prepared from large-kerneled, steam-crushed oats that have been cleaned thoroughly to eliminate the weed seeds and the small cracked kernels so attractive to birds. The preparation and distribution of such baits by the Biological Survey represent a great improvement over the methods previously employed by private landowners, and these are far superior in effect to the commercial poisons used with wheat and other small grains, or bait intermixed with small seeds, particularly as the commercial products often carry phosphorus, arsenic, and other poisons dangerous to bird life.

An example of the value of the control-methods laboratory was furnished near Denver, Colo., a short time ago. Local telephone officials had asked for assistance in devising methods for controlling crows over a stretch of country traversed by their lines. These birds were building their nests in the wires as well as on top of the poles, and were using as a base pieces of scrap wire picked up in the surrounding country. This caused short circuits in the telephone lines and necessitated the employment of a number of men to keep the wires free from interference. Investigation and experiment at the research laboratory developed a bait acceptable to the crows, and in a short time this disposed of the birds frequenting the line. The telephone company's expenses for line service were reduced thereby from \$36 to \$6 a day, and the estimate of total savings since the control methods were applied was \$1,250.

During the year a Technical Bulletin (No. 134), entitled "Red-Squill Powders as Raticides," was published, and a manuscript prepared on the same subject for popular publication in the leaflet series. Porcupine Control in the Western States, a leaflet (No. 60) giving information on the control of this rodent destructive to trees, was also published following research work, and a report was practically completed on the chemical and physical properties of thallium for use in rodent baits. In the 1930 Yearbook of Agriculture, under the title Rodent Control Aided by Mixing Bait at Cooperative Stations, a full description was given of methods followed at the station maintained by the Biological Survey at McCammon, Idaho, to insure that cooperating control workers shall be provided with a uniformly toxic bait prepared in accordance with methods developed by control research workers.

COOPERATION IN WILD-LIFE CONTROL

EXTENT OF COOPERATION

The Biological Survey has not been able to meet all the demands for assistance that have come from States where predatory animals

levy their annual toll on the livestock interests. In addition to killing sheep, calves, pigs, and poultry the predators are also a great menace to wild birds and to such game mammals as deer and elk. Prairie dogs, ground squirrels, and jack rabbits cause large annual losses in the Western States, but these do not compare in monetary terms with those sustained east of the Mississippi River through depredations of house rats; in some areas pine mice and pocket gophers are exceedingly destructive also. In consequence the demand for assistance in rodent control has become nation-wide. Although it has not been possible for the Biological Survey to render direct assistance in response to all requests received, no request has gone without attention. Wherever possible personal assistance has been given, but where this could not be done information was furnished suggesting measures of control.

The services of the Biological Survey have consistently been based upon cooperative agreements with livestock, agricultural, or conservation organizations in the States where its representatives have been stationed. As an indication of the general spirit of cooperation between the bureau and other agencies interested in this line of work it may be noted that \$1,528,565 was made available during the past fiscal year by States, counties, agricultural organizations, and individuals to help carry on the control campaigns in cooperation with the Biological Survey.

Closer cooperation with the Bureau of Indian Affairs of the Department of the Interior and a better understanding between field forces of the two bureaus have resulted from a cooperative agreement now in effect. This agreement specifies that the supervision of all needed predatory-animal and rodent control operations on Indian reservations shall be furnished by the Biological Survey, with the Indian Bureau supplying its proportional share of equipment and help. It will facilitate control operations on many of the Indian reservations in the West.

Federal and cooperative funds available during the year permitted organized field work in the control of predatory animals and injurious rodents in 36 States. Federal funds available totaled \$569,594, of which \$34,834 was used in research at the Denver laboratory; \$325,974 in the control of predatory animals; and \$208,786 in the control of rodents. The States provided \$495,441 to use in the bureau's control operations, while counties, livestock associations, and individuals furnished \$1,033,124; thus, the total made available by cooperators was \$1,528,565 for conducting the organized control campaigns.

THE 10-YEAR CONTROL PROGRAM

From the time of its inception, the Bureau of Biological Survey has been making investigations of the various forms of wild animals inimical to agriculture, horticulture, forestry, livestock, and game. One of its earliest publications, Circular No. 3, issued in 1886, dealt with the economic relations of mammals. Investigations have continued to the present time, and are still being conducted, on the relations of predatory animals to livestock and game; of rodents to agriculture, horticulture, and forestry; and of predatory animals to rodents.

The damage inflicted by predatory animals and rodents to livestock and crops, and previous outbreaks of rabies, had led Congress to authorize in the appropriation act of June 30, 1914, for the fiscal year 1915, "experiments and demonstrations in destroying wolves, prairie dogs, and other animals injurious to agriculture and animal husbandry," though demonstrational work in the control of injurious rodents, chiefly on public lands, had been undertaken several years previous. An impetus was given control operations by an emergency appropriation in 1916 of \$75,000 for the suppression of rabies in wild animals, chiefly coyotes. The difficult task of building up an organization and developing methods of control was given the Biological Survey. Since that time, appropriations have materially increased, but cooperative funds have grown in even greater degree, until States, counties, organizations, and individuals now contribute three times as much money for expenditure under the direction of the Biological Survey as does the Federal Government.

The success thus far attained with the limited resources indicates the even greater accomplishments that might be expected if the bureau were fully equipped to carry out an adequate control program. Congress gave this matter consideration, and as a proviso to the act making appropriations for the department for the fiscal year ended June 30, 1929, called for an investigation as to the feasibility of a cooperative program for the control of these wild-animal pests, extending over five or more years. This investigation was made, and a report thereon recommending a 10-year program was submitted to Congress.

In the recent session of Congress bills were introduced in both Houses to authorize the institution of this 10-year control program. The proposal was approved by the Bureau of the Budget in March, and hearings before the House Committee on Agriculture were held a month later. Strong indorsement of the measure was given by many national, State, and local organizations, including State legislatures, State agricultural commissions, farm bureau federations, cattle, sheep, goat, and poultry raisers' associations, horticultural societies, associations of the fur industry, sportsmen's organizations, State fish and game departments, chambers of commerce, and others, though some objection was made by naturalists, individually and through their organizations, who feared threatened extermination of certain predatory animals and opposed some of the control methods employed.

It has previously been pointed out that the program of the organized cooperative campaigns has been from the start one of local suppression rather than complete eradication of species. Such control operations as are recommended or undertaken are in the interests of man and his economic welfare, and, though necessary, the thought of destroying interesting wild animals is as abhorrent to those directing the work as to the many other lovers of wild life throughout the country. It is a task, however, that calls for use of the most efficient methods that can be devised. Before the close of the year plans were laid for undertaking additional investigations in the food-habits research laboratory of the bureau in Washington of the food of the various larger mammals, especially of the coyote. These studies will supplement the large existing record of stomach examinations in the field and other records already available in the bureau. Tentative

plans were made also for establishing at an early date a field laboratory at some central point in the West.

Recent opposition by a group of naturalists to the control operations of the bureau has been based on the assumption that insufficient preliminary research has been undertaken and that inadequate safeguards were being thrown about the use of poison for predatory animals in localities where fur animals might be endangered. Augmentation of the research program should have the effect of giving full and satisfactory answer to such criticisms. To make fully evident, however, the nature of the field operations and their possible effect on species other than those for which control is intended, arrangements are being made to have trained naturalists of the bureau assigned during the coming year to cover typical poison and trap lines in the West in conjunction with the local operatives of the bureau. Furthermore, invitation has been extended to representatives of zoological societies and scientific institutions to accompany bureau naturalists on these check-up and investigational trips, to observe the methods employed and to suggest corrective practices where these are deemed necessary.

CONTROL OF PREDATORY ANIMALS

Predatory-animal control operations were conducted during the year in portions of all States from Montana to Texas and westward to the Pacific coast, and also in South Dakota and in parts of Oklahoma and Arkansas. In addition, cooperative work was entered into late in the year in Minnesota, Wisconsin, and Michigan at the request of the respective State game and fish commissions, and three experts in predatory-animal control were detailed as leaders of the work in these States.

Requests for assistance were received also from North Dakota, Iowa, Kansas, Illinois, Indiana, Missouri, and Nebraska, but funds did not permit extending field assistance in these areas with the exception of a few months' work in coyote control on the Nebraska National Forest in the interest of game protection. These States contain enormous breeding areas for such predators as bobcats, coyotes, and wolves.

In cooperation with and at the request of the Virginia Commission of Game and Inland Fisheries, a trained predatory-animal hunter was detailed from Wyoming to parts of Virginia, where six months' work was undertaken in the control of bobcats, for the protection of deer. Previous field observations had been made by two biologists of the bureau, who found these valuable game mammals to be suffering from bobcat depredations.

Cooperative work for the control of wolves and coyotes continued in Alaska, chiefly with the object of training local trappers. Field surveys on the islands of Wrangell, Etolin, Brownson, and Deer revealed the presence of wolves and showed that a great many deer had been killed recently by these predators.

As in previous years control operations in general included trapping, poisoning, and den hunting, with occasional hunting with trained dogs. In many States where control work was undertaken no poison was used. In fact the only States in which poisoning operations were conducted were in the Rocky Mountain and Great

Basin regions, in parts of the Pacific Coast States, and in the western parts of South Dakota and Texas. In addition, no work of control of any nature was done by the Biological Survey in any of the national parks.

In the control operations conducted by the Biological Survey, a year-long average of only 505 Federal, State, and cooperative hunters were employed, and many of these used no poison. These men engaged in work over the whole area of the States in which predatory-animal control was carried on, a very limited region compared with the total range of the predators over western stock country and on the public domain, including national forests and parks. Furthermore, information gathered throughout the West indicates that there are at least 8,000 men not connected in any way with the Government, a large number of whom are professional trappers, engaged in poisoning predatory animals. Compared with the total number thus working with poisons, the representation of the Biological Survey is limited, indeed. Moreover, it is highly significant that the Government employees are responsible men, working under competent direction, and that all possible safeguards are thrown about their operations for the protection of harmless and valuable species of wild life.

The bureau has a definitely established policy regarding safeguards in the use of poisons, and if a supervisory officer ascertains that his instructions to a field worker are not implicitly followed, he is authorized and directed to take prompt disciplinary action. It is highly desirable, in the interest of wild-life conservation generally, that control measures be under competent direction. It should be a source of general gratification, especially to naturalists and other scientific men, that operations by the Government for the control of injurious wild animals are conducted by biologists and other field agents of a bureau that is recognized for its interest in the conservation of the wild-life resources of the Nation, rather than by men whose dominant interest is merely increased economic production.

WOLVES AND COYOTES

Field observations by the Biological Survey over more than 25 years warrant the assertion that the coyote is the most destructive natural enemy of livestock and wild life in the western country. Though at certain times of the year it obtains a goodly portion of its diet from injurious rodents, it must be conceded that the coyote alone can not be relied upon to keep them in check. This fact becomes evident when it is considered that rodent plagues occurred long before any material reduction of the coyote population was brought about by advancing civilization, and that unusual outbreaks of rodents are still noted in areas where coyotes occur in large numbers. Again, many cases have been noted where coyotes inhabiting rodent-infested areas have raided sheep bands, pigs, poultry, or wild life. Such raids are general throughout the coyote range where rodents and farming, stockraising, and game interests are closely associated. Nor has the coyote served to stop the prairie dog in its gradual and effective infestation of the national forests and of large areas of the

public domain. This holds true likewise with respect to its relations to the jack rabbit, the pocket gopher, and the ground squirrel.

Sporadic outbreaks of rabies among coyotes occurred during the year in Nevada, Oregon, California, Utah, and Washington. To cope with the situation in Washington, \$1,500 was obtained from the Secretary's reserve, and three hunters have been kept continually in this section since the first rabid coyote was killed in September. In Oregon the outbreak occurred among dogs and coyotes during January and February, and approximately 60 head of cattle died from the disease. To curb coyote infestation, bureau hunters were placed in the field in cooperation with the Harney County Court and the Oregon State Live Stock Sanitary Board, and an additional \$500 was released by the Secretary from his reserve. All dogs were quarantined and vaccinated, and dogs running at large were either vaccinated or killed. The outbreak of rabies in Utah occurred during the winter, and its spread to adjacent sections was prevented by cooperation on the part of the bureau with the State boards of agriculture and of health.

In the past few years coyotes in Colorado have been reported as turning more and more to the killing of young calves. A Hereford breeder in this State, who keeps all purebred cattle under fence, last year lost 12 calves and a yearling from coyotes. The destruction of 72 coyotes on this range stopped all losses.

The number of coyotes killed during the year, as revealed by skins and scalps recovered, exceeded that of the previous year. By far the greater part were removed from livestock ranges and farm sections. Because of the possible danger to fur animals no intensive work, and in many cases no work at all, was done in breeding areas of coyotes where martens, fishers, foxes, skunks, and other important fur bearers were in evidence.

Gray and red wolves still commit depredations in Texas, Oklahoma, Arkansas, Wisconsin, Minnesota, and Michigan, and a field survey showed their prevalence in northern Louisiana. The gray wolf also is constantly crossing the Mexican border into Arizona and New Mexico. Operations for the control of gray and red wolves were most extensive in Texas, Oklahoma, and Arkansas, the work in the Lake States not getting under way until near the close of the fiscal year.

To meet the many requests for information on trapping emanating from private trappers, game conservationists, stockmen, and farmers, a leaflet entitled "Hints on Coyote and Wolf Trapping" was prepared and was in press at the close of the year. It will be especially useful in supplying information when direct personal aid can not be rendered.

MOUNTAIN LIONS

Operations by the Biological Survey in cooperation with the various States were undertaken for mountain-lion control on stock and game ranges in parts of Oregon, New Mexico, Colorado, Montana, Washington, Utah, Texas, Idaho, Nevada, and California. Trained dogs as well as traps were used and these measures resulted in satisfactory control of depredations.

BEARS

Each year increasing requests are made upon the bureau for the removal of alleged stock-killing bears. As stated repeatedly, it is the policy of the Biological Survey to establish the fact that bears are responsible for stock-killing that has been reported before the bureau will authorize measures for their control. The degree of caution exercised by field workers of the bureau in determining the facts frequently leads to criticism from cattle growers, the opinion often being voiced that the bureau should take more prompt action for the removal of bears from the stock ranges. The protection of innocent bears in such cases is not a simple matter. Nevertheless, the policy as stated is being rigidly adhered to.

BOBCATS AND CANADA LYNXES

Increasing numbers of requests for information regarding bobcat control have come from the Eastern States. A forthcoming leaflet of the department will give essential information showing that the bobcat feeds, to a large extent, upon rabbits and other rodents, but at the same time that it can be and often is exceedingly destructive to young lambs, goats, antelope, pigs, calves, and poultry, and preys upon deer, especially fawns, and wild turkeys, quail, and other ground-nesting birds. Sheep are more often attacked at lambing time on open ranges that are in close proximity to the broken, rough, and rocky canyon country that forms the regular habitat of this predator. Depredations on livestock by the Canada lynx in no way approach those occasioned by the bobcat, though at times they are responsible for losses among young lambs, particularly on the higher spring lambing ranges. Work for the control of these predators has been carried on in many localities throughout the year so far as was possible and necessary.

HOUSE CATS

In last year's report mention was made of increasing depredations by house cats that revert to wild habits, often because of neglect and abandonment by their owners. A leaflet (No. 50) presenting directions for taking and disposing of vagrant cats was published during the year under the title "How to Make a Cat Trap." Many requests have been made for this leaflet, more than 18,000 copies being distributed between November and the end of June. The testimony that house cats, when they revert to the wild state, are the most destructive agent to bird life is piling up year by year, and the time is not far distant when conservationists and game administrators will demand the institution of such control measures as will greatly reduce their abundance.

BOUNTY FRAUDS

Through the agency of a predatory-animal hunter of the bureau working during the year in the State of Washington, the operations of thieves illegally collecting bounties on bobcats were broken up. Several counties of the State were paying bounties of \$5 on bobcats, and the large numbers of skins being presented for the payments led one county official to make inquiries of the Biological Survey hunter.

whose ordinary catch, it was disclosed, was not more than 4 or 5 in three seasons. A check-up at once followed on a claim presented on 34 bobcats, the claimant stating on affidavit that the animals had been taken in the immediate vicinity within the past 30 days. Further investigation resulted in arrests, and it was developed that this claimant had already collected \$645 in bounties on 129 "bobcats," most of which were ocelots, small animals of the Southwest, and southern wildcats, also taken outside the State. Other evidences of similar fraudulent bounty claims in the State were soon disclosed, the irregular claimant in one case proving to be a man who had been strongly condemning the paid-hunter system of the Federal Government.

Similar bounty frauds in Kansas reported during this year, in connection with coyote control, involved payments of bounties by the State over a period of 18 years aggregating, it was estimated, \$180,000. Arrest of four dishonest hunters, who had been operating over 80 counties, broke up the nefarious business, the men receiving penitentiary sentences.

These are particularly pernicious examples of the operations of the bounty system, and show how it may lead to the extensive destruction of wild animals other than those for which control measures are designed. In the sections of the country mentioned, at least, the arrest of the dishonest bounty hunters gave general demonstration of some of the serious disadvantages of the bounty system as compared with predatory-animal control by responsible salaried workers.

CONTROL OF INJURIOUS RODENTS

One Biological Survey investigator has ascertained that 385 ground squirrels consume as much forage as will one cow. Another reports that 14 jack rabbits eat as much dry feed as a sheep, and 71 of them as much as a cow. These destructive rodents infest western range lands literally by the millions, taking forage that now should be available to valuable cattle and sheep. Farmers in areas heavily infested with ground squirrels, prairie dogs, and jack rabbits find it absolutely essential to control these pests if crops are to be grown profitably. That damage to crops and forage is not the only charge against these rodents was exemplified in stockmen's reports that pocket gophers and other rodents in Arizona during July and August last year burrowed through the embankments of reservoirs and when the rains came and filled them the dams washed out, necessitating repairs costing \$80,000. Field operations of the Biological Survey have shown that effective control of rodents can be accomplished only by thorough-going cooperation of all landowners, and by systematic and simultaneous treatment of large areas. The bureau has developed poison formulas, methods of distributing baits, and a trained personnel to assist landowners in these campaigns. Such organization has resulted in the control of rodent pests on millions of acres of valuable agricultural and grazing lands and has been attended by large direct savings and increased production of important crops. In years of severe drought like the present it is especially important to lessen the competition of rodents with livestock for the limited range forage produced.

Organized rodent-control operations (including demonstrations in combating moles) have been carried on in 27 States, and educational work in 5. In addition to furnishing expert advice and leadership in organizing and conducting control campaigns, the Biological Survey is given the responsibility of rodent control on vast areas of public domain in the West. Such lands must be treated systematically if lasting results are to be obtained, both on these lands and on adjacent areas.

GROUND SQUIRRELS

Ground squirrels of various species are generally distributed over the States west of the Mississippi River and are found also in Wisconsin, Illinois, Michigan, and Indiana. Their damage is not limited to the destruction of crops and forage, but includes also serious injury to irrigation ditches, caused by their burrowing through the banks and allowing the water to escape. In some sections of the West, farmers and ranchers find it impossible to raise crops of any kind without undertaking some measure of ground-squirrel control. These rodents heavily infest mountain valleys, and in such districts all lands—State, Federal, and private—must be treated in a systematic manner, with follow-up work to prevent later reinfestation.

The effectiveness of systematically organized operations against ground squirrels is exemplified in the Star Valley, western Wyoming, which is completely surrounded by squirrel-infested mountains. Here a unit of valuable farming land was cleared of ground squirrels four years ago by a crew under Biological Survey supervision. The squirrels are now being kept from this valley by a small crew working on the outskirts each year. Last year an area of more than 60,000 acres was treated at a cost of 1 cent an acre. No loss is being suffered at the present time, whereas five years ago, before the present system of defense was adopted, the loss was reported to exceed \$25,000 a year.

PRAIRIE DOGS

Prairie dogs live in large colonies or towns, usually in the finest grazing areas, in the Plains States and westward to the foothills of the Rocky Mountains, as well as in Utah, New Mexico, Colorado, and Arizona. In many cases after control operations have been satisfactorily conducted native grasses can be cut as wild hay. In Colorado, on one national-forest allotment, the grazing capacity of the range was increased from 250 head of cattle in 1925 to 500 head in 1929, largely as a result of the work of paid crews supervised by representatives of the Biological Survey. The forest supervisor in charge of this district considers that the control of the prairie dog on this specific unit has been largely responsible for doubling the carrying capacity of the range in the 4-year period.

JACK RABBITS

Jack rabbits, which inhabit practically all the territory west of the Mississippi River, are responsible for large losses in farm crops and range grasses, and in many localities also in hay and grain in stacks. In previous years they were a serious menace in many localities, but

during the past year their numbers were greatly reduced, until at the present time their damage is slight. Extensive control operations against jack rabbits by the Biological Survey and its cooperators, the high price paid for skins by fur companies, and a disease that made serious inroads on their numbers were found to be responsible for this decrease. Jack rabbits are carriers of tularemia, a disease that not only causes the death of many rabbits and other rodents but is also transmissible to man. The bureau demonstrated the market value of rabbit skins in exhibits at fairs in Arizona during the year.

POCKET GOPHERS

The need for pocket-gopher control is very generally recognized, both in Western and Eastern States. Where measures of suppression are not taken the animals damage growing crops, shrubs, and fruit trees, and cover and destroy vegetation by the mounds they throw to the surface, and at harvest time the piles of earth interfere with mowing machinery. These rodents also are a decided factor in erosion and soil loss in many areas, particularly in the Western States. In some mountain parks pocket gophers have become so numerous as practically to destroy all vegetation. The loss they occasion in burrowing through irrigation ditch banks and reservoirs, including the resultant flooding, is very great; one Texas nurseryman, for example, reported during the year that 70,000 citrus cuttings and \$2,500 worth of nursery stock were destroyed in this way by pocket gophers before the damage was stopped by representatives of the Biological Survey. Many calls have been made for assistance also in eliminating pocket gophers from airport fields, their mounds constituting a serious hazard to the safe landing of airplanes.

WOODCHUCKS

Woodchucks are not usually a serious farm pest, as they frequent rocky areas, woodlands, and thickets. At times, however, they may become destructive in fields adjacent to such places. Damage by woodchucks has been of increasing importance of late years in some of the Eastern States, and demonstrations have been made and information has been distributed by the bureau instructing landowners in methods of control. A motion-picture film to assist in disseminating information regarding control chiefly in the Eastern States was released during the year.

PORCUPINES

In their choice of food, porcupines are not fastidious, but consume succulent plants of many species and the buds, leaves, and inner bark and cambium of numerous kinds of trees. During the summer they generally feed upon juicy ground vegetation. In the West in fall and winter, however, their diet consists largely of bark and leaves of coniferous trees, especially the western yellow pine and several species of juniper. Because of these feeding habits the damage to cultivated crops caused by porcupines occurs chiefly during spring and summer and includes the destruction of young fruit trees, the defoliation of mature ones, and the destruction of alfalfa and truck

crops upon which they feed. During the fall and winter the most serious damage from an economic standpoint is caused by their injuring or killing young forest trees. At this time of year porcupines in their efforts to get at the inner layer of bark often partly or completely girdle the main leaders or boles of trees. Many small seedlings (up to 5 years of age) are completely destroyed, while the larger ones frequently suffer injury serious enough to cause death, but more often this injury results in a weakened bushy topped or spike-top tree useless for commercial purposes. In areas of heavy infestation 10 to 100 per cent of the young growth is frequently so damaged as seriously to interfere with any successful program of reforestation and forest management.

The control of the porcupine has been stimulated during the year by reason of the increasing numbers of these animals throughout their range in the Western States, and the development of efficient control methods has been called for. Control measures of a rather simple nature have been worked out by the investigators of the bureau, and these have been used to excellent advantage in the forests of several of the Western States where porcupine damage was excessive. A leaflet (No. 60) describing methods of control was issued.

BROWN RATS

The brown rat, introduced from the Old World into America and now present in every State of the Union and in Alaska, is the most destructive of wild-animal pests. The thickly settled Eastern States suffer more from its work than do the areas farther west. Control measures are exceedingly difficult when an abundant food supply and ready shelter are available for it. Crops and forage, stored grains, and foodstuffs are among the products it wastes, and it is also a carrier of the dread bubonic plague and other diseases of man. With such an indictment against it, unrelenting measures to lessen its numbers are demanded.

Organized rat-control campaigns, directed by field leaders of the bureau, have been carried on in practically every State east of the Mississippi River, and in South Dakota, Colorado, Montana, Washington, Texas, Oregon, and Utah. In the East 128 campaigns were conducted, mostly in towns of 2,000 to 50,000 population, though an increasing number were held on the county-wide basis. Work was supervised on 50,700 separate premises, at a total cost to cooperators of \$17,545, or an average of 35 cents for each piece of property. A check-up of results indicates that about 75 per cent of the premises treated were entirely freed of rats.

Up to 1928 the chief poison used in rat-control operations was barium carbonate, but in that year Biological Survey investigators developed methods employing powdered red squill for the purpose. This has proved to be a most effective raticide, has the advantage of being specific for rats and mice, and its sale by commercial manufacturers has increased to more than 125,000 pounds annually. Additional information on rat control was presented during the year in connection with special exhibits at fairs in Texas.

Farmers' Bulletin No. 1533 on rat control was revised and reissued during the year, and is among the publications of the department in greatest demand by the public in all sections of the country. This

will soon be supplemented by an additional publication on rat-proofing methods prepared during the year in cooperation with the Bureau of Public Roads.

FIELD MICE

Outbreaks of field mice occurred during the year in South Dakota and Oregon, the damage to wheat fields over some 5,000 acres in South Dakota alone amounting to more than 2 bushels to the acre, at a time when the grain was selling at 98 cents a bushel. Prompt control methods by bureau representatives in the State stopped the mouse plague, and no serious difficulty has been experienced there since.

In orchards mice using weeds and grass as cover frequently burrow about the roots of trees and eat the bark and cambium layer, girdling and causing the death of the trees. Such damage is of common occurrence every year throughout the Middle Western and Eastern States. The Biological Survey has actively assisted eastern orchardists in the control of field mice this year, the work having the effect of protecting more than a million fruit trees, at a cost of approximately half a cent a tree. General aid in mouse control was given by the issuance in revised form of Farmers' Bulletin No. 1397 on Mouse Control in Field and Orchard.

CONTROL OF MOLES

Moles are very troublesome in lawns and gardens in the Pacific coast region and in the eastern portion of the United States, but their principal damage is in bulb-raising sections of the west coast. As their food consists of insects, it is more difficult to poison them than pocket gophers and other burrowing rodents. The experimental force of the Biological Survey, however, has been working on control methods during the year that promise satisfactory results.

ACQUISITION OF WILD-LIFE REFUGE AREAS

FEDERAL AND STATE ENABLING ACTS

The migratory bird conservation act of February 18, 1929, became effective on July 1 of that year, when the funds necessary for carrying out the migratory-bird refuge program became available. This most important legislation was the culmination of years of activity on the part of wild-life conservationists for the establishment of sanctuaries for ducks, geese, and other migratory game birds throughout the United States. Its passage and administration mark further steps in this country's efforts to carry out its treaty obligations with Great Britain for the protection of the birds that twice, each year, in spring and fall, migrate between the United States and Canada.

The responsibility of selecting and negotiating for the areas that will contribute so materially to the preservation of our wild fowl lies with the Bureau of Biological Survey, and in planning judicious expenditure of the funds appropriated and authorized by the act, aggregating approximately \$8,000,000 over a period of 10 years, the

extensive knowledge and voluminous data in the possession of the Biological Survey have been fully utilized.

The migratory bird conservation act embodies a clause requiring the consent of the States to the acquisition of lands therein by the United States before the Federal Government can make purchases. Requisite action has already been taken in all but the following 17:

Alabama	New Hampshire	Texas
Arkansas	New Jersey	Utah
Delaware	North Dakota	Vermont
Idaho	Oregon	Washington
Indiana	Pennsylvania	Wisconsin
Massachusetts	Tennessee	

It is trusted that many if not all of these States will take appropriate action at the next sessions of the legislatures.

Early in the year a pamphlet was issued (Bi-1018) describing the procedure to be followed by persons having lands suitable for refuge purposes to dispose of; and in the 1930 Yearbook of Agriculture, under the title "Migratory-bird Refuges to be Increased under New Conservation Act," a popular explanation was made of the necessity for establishing the refuges, the steps leading to the passage of the new law, and the measures to be followed in the acquisition and administration of suitable areas.

PROGRESS IN LAND EXAMINATIONS

Under the \$75,000 made available on July 1, 1929, investigational work was instituted, as already mentioned, on the wild-fowl food resources, existing and potential, of areas recommended. In addition, to determine accurately the types of land, the uses intended, and the character, extent, and value of existing improvements, intensive examinations were made of the lands embraced by desired units. Ownership data also have been gathered, valuation studies made, and records and maps compiled. At the end of the year this work had been conducted in 24 States, covering 40 units over a total of approximately 1,225,000 acres of land and water.

As a result of studies made, 2 areas of Federal lands have been withdrawn by Executive order for reservation for bird-refuge purposes, and investigations with a similar end in view are in progress on 5 others. Since the first of April, negotiations have been conducted for the purchase of 8 refuge sites, for 2 of which purchase agreements have been reached, and approval of the proposed action was given by the Migratory Bird Conservation Commission, on May 26, 1930. One of these is a tract of 32,000 acres on the coast of South Carolina, a little north of Charleston, made up of a group of large islands, marshy in character and interlaced with winding channels, all making an area most attractive to the migratory birds that follow the eastern seaboard in spring and fall migrations. Besides being a haunt of several species of ducks, it is noteworthy because of its attractiveness as a nesting area of Wilson's plover and the willet. The ruddy turnstone, the black-bellied plover, and small sandpipers seek this region in their migrations, while colonies of black skimmers, terns, and herons also find haven here. The oyster catcher, a large strikingly colored shore bird, almost extinct by reason of relentless shooting, is present on this area in some abundance and will find sanctuary in the new refuge.

The second unit approved for purchase by the Migratory Bird Conservation Commission is in the San Luis Valley, Colo. This is an area of more than 5,000 acres in the south-central part of the State, where there are several lakes and sloughs in an otherwise arid region. It is of outstanding importance, being the only attractive stopping place for ducks in their migrations through this great inter-mountain region of the West. A refuge here will do much to conserve the mallards, pintails, and gadwalls that use this line of flight.

BEAR RIVER MIGRATORY BIRD REFUGE

Contracts have been let for construction work and improvements necessary to correct conditions that have proved so destructive to waterfowl in the area of the Bear River Migratory Bird Refuge, in Utah, during the past decade. The first three of the units making up this refuge have been practically completed, and a contract has been let for the remaining two. In addition to the river-control structure, which provides a means of diverting the water supply into either one or all of the five units, there are to be feeder canals leading into each. A massive outer dike approximately 20 miles long will hold back sufficient water to flood about 25,000 acres of land.

The establishment of this important refuge was authorized by act of Congress on April 23, 1928, and on July 23, 1928, following an examination of the land situation there, an Executive order was issued withdrawing all public lands within the zone to be developed. The purpose of this refuge is not only to provide a sanctuary for waterfowl in the seasons of migration, but so to improve the condition of the water as to prevent the heavy mortality among the birds that has occurred in former years, chiefly from alkali poisoning.

In addition to 30,632 acres of public lands withdrawn for refuge purposes, 15,861 acres were acquired during the year at an average cost of \$1.55 an acre, and 7,861 acres were taken under lease. Of the leased lands, 7,126 acres will shortly be acquired in fee by the United States through the exchange of public lands in the vicinity of the refuge that are not used for refuge purposes, authorized by the special exchange act of February 15, 1929, passed in aid of this project. In addition the State of Utah has ceded jurisdiction over 2,133 acres of its land within the limits of the project. The total area now under control, including that to be flooded, is approximately 56,487 acres. Except for the completion of the steps required incident to the actual transfer of the lands under exchange agreement previously referred to, the acquisition of all lands within the Bear River Migratory Bird Refuge has been completed.

CHEYENNE BOTTOMS MIGRATORY BIRD REFUGE

By act of Congress, approved June 12, 1930, the Secretary is authorized to acquire 20,000 acres of land in what is known as the Cheyenne Bottoms, in Barton County, Kans., for migratory bird refuge purposes. This area consists of a natural depression in an otherwise prairielike region, and contains the only extensive lake in the State. The Biological Survey had previously made exhaustive investigations as to the suitability of the site for this purpose and had also made an intensive economic survey of it.

The body of water on this area is the objective of immense numbers of migratory wild fowl and shore birds in their semiannual flights. It is the most suitable haven for them within a radius of hundreds of miles. Because of the unusual ownership and title situation here, apparently precluding acquisitions by direct purchase from the owners, it would seem necessary to resort to condemnation proceedings to vest safe title to the property in the United States. Funds were made available to the Biological Survey for initial steps toward the consummation of measures for the acquisition of the refuge effective July 1, 1930.

MIGRATORY BIRD CONSERVATION COMMISSION

The Migratory Bird Conservation Commission was created by the migratory bird conservation act of February 18, 1929 (45 Stat. 1222), to consider and pass upon areas of land, water, or land and water that may be recommended for purchase or lease by the Secretary for refuge purposes. The commission consists of the Secretary of Agriculture as chairman, the Secretary of Commerce, the Secretary of the Interior, Senators Peter Norbeck and Harry B. Hawes, and Representatives Ernest P. Ackerman and Sam D. McReynolds. The commission held its first meeting on May 15, when it considered methods of approach to the accomplishment of the refuge program and completed its organization by the appointment of Rudolph Dieffenbach, in charge of the division of land acquisition of the Bureau of Biological Survey, as its secretary. A second meeting was held later in the month when a detailed purchase policy was formulated and approved, and reports submitted by the department were considered and approved on the two refuge sites for which options had previously been taken, the average price consideration for the two areas being \$1.13 an acre.

The next meeting of the commission is scheduled to be held in December, when other matters for its attention will have matured.

MAINTENANCE OF WILD-LIFE RESERVATIONS

The movement so pronounced last year for the establishment of refuges for the restoration of wild life has been continued, as evidenced by both Federal and State action. This form of conservation may well be considered one of the best established principles in wild-life administration. Its importance will be enhanced as both Federal and State funds are made available for the care and maintenance of areas dedicated as wild-life sanctuaries. Sound plans for the administration of sanctuaries include not only adequate policing but also the development of food resources and the maintenance or provision of a sufficient supply of water and other needs of individual refuges as affected by local conditions. The degree to which these requirements are met often determines the success that may be expected in attaining the objectives of sanctuary areas.

Difficulties arising through surplusage of animals on some of the existing big-game preserves have now been reduced to a minimum by systematic effort, and future control of the numbers of animals should be easier. It has become evident that when additional funds are made available for the construction of corrals and wing fences

the capture of surplus animals will be further facilitated. The numbers of big-game animals and their increase on preserves administered by the Biological Survey at the close of the year, other than on the Elk Refuge, are given in Tables 1 and 2. The herds are generally in good condition.

To aid inquirers in obtaining exhibition stock of big-game animals when the surpluses on preserves of the Biological Survey were not ample to fill all requests received, a mimeographed leaflet (Bi-1057) was issued listing, in addition to these and other governmental preserves, the names of dealers in live big-game animals.

A list of all wild-life reservations administered by the Bureau of Biological Survey, together with lists of bird refuges and game preserves on areas administered by other branches of the Federal Government, was issued during the year as Miscellaneous Publication No. 51.

BIG-GAME PRESERVES

NATIONAL BISON RANGE

A system of rotation grazing for the buffalo on the National Bison Range, near Moiese, Mont., made possible by the completion last fall of a division fence, should result in great benefit to the forage on the range, a portion of it already being in better condition than for a number of years. Disposal of surplus animals was continued to meet the grazing capacity, and during the year 107 buffalo and 36 mule deer were removed. Of the buffalo, 104 were sold for meat, and 3

TABLE 1.—*Animals on big-game preserves of the Bureau of Biological Survey, June 30, 1930*

Preserve	Buffalo	Elk	Antelope	Mountain sheep	Deer		Total
					White-tailed	Mule	
National Bison Range, Mont.....	320	¹ 151	29	37	¹ 10	¹ 110	¹ 628
Wind Cave Game Preserve, S. Dak.....	152	¹ 28	20		3		¹ 209
Sullys Hill Game Preserve, N. Dak.....	13	30	15		1		66
Niobrara Reservation, Nebr.....	117	¹ 113					¹ 246
Total.....	602	¹ 322	64	37	¹ 14	¹ 110	¹ 1,149

¹ Estimated.

TABLE 2.—*Young of buffalo, antelope, and mountain sheep born on reservations of the Bureau of Biological Survey during the calendar year 1929*¹

Preserve	Buffalo	Antelope	Mountain sheep
National Bison Range, Mont.....	67		13
Wind Cave Game Preserve, S. Dak.....	28	² 2	
Sullys Hill Game Preserve, N. Dak.....	3	8	
Niobrara Reservation, Nebr.....	20	4	
Total.....	118	² 14	13

¹ Figures omitted for young of elk and deer, as estimates only could be made.

² Estimated.

were removed alive for exhibition in parks and elsewhere. Of the deer, 35 were sold and shipped alive for park and propagating purposes, and 1 accidentally killed was sold for meat. The buffalo calf crop was better than last year, notwithstanding the fact that the total number of buffalo on the range is smaller than at the close of the previous year.

The elk herd shows a steady increase, but a number of the deer died last winter as a result of the severe cold. The herd of mountain sheep has been reduced to 37 animals by heavy losses that were apparently occasioned principally by a disease diagnosed by veterinarians of the Bureau of Animal Industry as chronic broncho-pneumonia. The fact that no carcasses have recently been found on the range would indicate that the disease has about run its course and that the sheep will again begin to increase in numbers.

ELK REFUGE

The number of elk that came to the feeding grounds at the Elk Refuge, in Jackson Hole, Wyo., during the winter varied at times from 4,000 to 7,000, some returning to the adjoining ranches and foothills whenever the weather turned warm. Only 4 were seen on the refuge before the hunting season closed, but by the end of December there were approximately 5,000 on the feeding grounds and in their immediate vicinity. Feeding, both by the bureau and the State game department, did not begin until February 6, and ended at the refuge on March 23, the State finishing feeding on the Sheep Creek foothills section on March 26. During the feeding period considerable warm weather was experienced, and at no time was the average depth of snow more than a foot. The open winter and the fact that the animals were widely scattered made it impossible to obtain an accurate count of the herds.

Approximately 825 tons of hay were fed, including that used for the work horses. Of this, 510 tons had been purchased by the State, and 315 tons were from the supply produced on the refuge. At the close of the feeding season, the bureau had 1,300 tons remaining, and the State 240 tons. Thus, 1,540 tons are available for feeding next winter. Nine hundred tons of hay were harvested on the refuge, including the Izaak Walton League addition, in the summer of 1929. A cold spring and an unusually dry summer combined to reduce the crop to about three-fourths of the normal yield. The forage on the open range and pasture was in far better condition during the early summer of 1930 than a year ago, and a larger hay crop is in prospect the coming fiscal year.

The elk came through the winter in exceptionally good condition with few losses from any cause, both on the feeding grounds and in the outlying districts. A corral has been constructed, and eight animals, captured early in the spring, are being held for study and experimental purposes. Representatives of the Bureau of Plant Industry visited the refuge last summer and made an examination of the hay meadows for the purpose of devising a plan for the control of squirreltail grass and for increasing forage production.

SULLYS HILL GAME PRESERVE

Two young male white-tailed deer were brought to the Sullys Hill Game Preserve, N. Dak., from the Upper Mississippi River Wild Life and Fish Refuge, and the antelope herd was increased by the birth of five fawns. Two antelope died apparently from mouth injuries received from eating oats that contained the seeds of the wild variety. The lesions occasioned by this feed abscessed and eventually resulted in death of the animals most severely affected. To restrict the big-game herds to conform to the carrying capacity of the range, three buffalo and eight elk were removed during the year. Of the buffalo, two were shipped alive for propagating purposes, one of them to the State Game and Fish Commission of Arizona, and one was sold for meat. Of the elk removed, 1 was shipped alive for exhibition purposes, 6 for breeding purposes, and 1 for meat.

The work of fencing an exhibition pasture has been completed to inclose about 16 acres, divided into three parts for elk, buffalo, and antelope, respectively. The preserve was visited during the year by 20,764 persons, with 4,825 automobiles.

WIND CAVE GAME PRESERVE

Forage was abundant in the pastures on the Wind Cave Game Preserve, S. Dak., during the year, and water was plentiful most of the time. Surplus animals disposed of included 61 buffalo and 25 elk. Of the buffalo, 38 were shipped alive and 23 butchered. Five of those shipped alive were gifts to municipal parks and zoological gardens, 10 were furnished for stocking purposes to the States of Arizona and South Dakota, and 23 were sold for propagation. Of the 25 elk removed, 11 were shipped alive for propagation and exhibition purposes, and 14 were sold for meat. Predatory animals are well under control about the preserve. Sharp-tailed grouse are more common than last year, and Chinese pheasants are reported occasionally.

NIOBRARA RESERVATION

The Niobrara Reservation, near Valentine, Nebr., is important both as a game preserve and as a bird refuge. Grouse have not returned to normal abundance from the setback of a few years ago, but are slowly recovering; ring-necked pheasants are gradually spreading into the region of the reservation, but quail appeared to be decreasing. Experiments in raising wild turkeys have not been wholly satisfactory, since their roving habits make it impossible to keep them within the boundaries of the reservation. In winter wild ducks in large numbers take refuge on the small ponds of this preserve. One of the ponds is near the highway that crosses the reservation, and the ducks can be seen by travelers in passing cars. This condition affords an interesting educational feature in connection with the preserve and has established a favorable local impression regarding the value of the refuge and the importance of game conservation. Surplus big-game animals removed during the year included 7 buffalo and 19 elk, all sold for meat. The animals now on the reservation and the range are in good condition and include three sets of twin antelope fawns. Predatory animals are not so

abundant as in former years, but the fences surrounding the pastures near headquarters in which the antelope range have been made coyote proof.

BIRD REFUGES

All but 1 of the 86 wild-life reservations administered by the Biological Survey in the United States, Alaska, Hawaii, and Porto Rico are duly constituted bird refuges. These include the 4 big-game preserves, the elk refuge, and an island reservation in Alaska for conducting experiments in the propagation of reindeer and caribou, the exception being 1 muskrat and beaver preserve in Alaska. Wild life generally is protected on these, but 2 are especially for mammals, birds, and fishes, while 77 are maintained primarily for birds.

NEW REFUGES

Four new bird refuges were established during the year: (1) Cedar Keys Refuge, off the west coast of Levy County, Fla., embracing Snake Key, Dead Man or Bird Key, and North Key, in the island group known as Cedar Keys, will serve as an important nesting and wintering ground for considerable numbers of aquatic birds, including several species of herons, pelicans, and cormorants, some of which were becoming greatly depleted in numbers. (2) Benton Lake Refuge in Cascade and Chouteau Counties, Mont, near the city of Great Falls, embracing an area of more than 12,000 acres, constitutes an important sanctuary for great numbers of migratory waterfowl. More than 3,000 acres of the refuge is water area, with an abundance of aquatic plant growth for cover and food for wild fowl. Several species of wild ducks, as well as wild geese, are found on the Benton Lake marshes during their migration, and some of these birds breed there. Shore birds also frequent the region, chiefly in migration. (3) Salt Plains Wild Life Refuge, comprising approximately 20,000 acres in Alfalfa County, Okla., will constitute an important link in the network of refuges to be established throughout the country under the migratory bird conservation act. (4) Wolf Island Wild Life Refuge on a portion of Wolf Island, off the coast of Georgia, between Doboy and Altamaha Sounds, which was formerly used by the Department of Commerce as a lighthouse station, is valuable as a resting, feeding, and breeding ground for waterfowl and other aquatic birds.

HAWAIIAN ISLANDS RESERVATION

Arrangements were completed this year for the protector to visit Laysan Island of the Hawaiian Islands Bird Reservation early in the coming fiscal year for the purpose of inspecting wild-life conditions there. The widely scattered units of the reservation render it impossible to provide for regular inspection of all the areas in the absence of special equipment necessary for adequate patrol purposes.

LAKE MALHEUR BIRD REFUGE

The extremely dry season in the region about Lake Malheur Bird Refuge, in Oregon, has resulted in greatly restricting its water area,

which may reach a lower stage than during any season in the past decade. Investigations have been conducted at this point to determine the possibilities of augmenting the present water supply or of developing an independent supply to care for the needs of the reservation. The question of ownership of lands in the lake bed and its immediate vicinity continues to be a serious obstacle to further development of this refuge. A bill that has been pending in Congress for several years to authorize litigation on this subject was passed, but owing to the fact that it involved the determination of water rights throughout the entire drainage system, its veto was recommended by the Attorney General. He suggested, however, that the purpose of the legislation might be accomplished without the aid of a special act. Because of the importance of this refuge to the waterfowl situation in the northwestern portion of the country, it is desirable that development work be undertaken at the earliest possible date.

ALEUTIAN ISLANDS RESERVATION

Need for extensive repairs to the boat *Seal* caused a postponement to the summer of 1931 of a tour of inspection of the Aleutian Islands reservation planned by the Alaska Game Commission. No important inspections have been made of the greater part of this reservation for several years, and the information to be obtained by a general tour to the Aleutian Chain will be of great value in future administration. By the granting of provisional permits, natives of the islands have been encouraged to undertake the propagation of foxes where such operations would not interfere with the welfare of birds. Plans also have been advanced for the transfer of the direct administration of this reservation to the chief representative of the Biological Survey in Alaska.

BIG LAKE BIRD RESERVATION

Thousands of ducks, such as mallards, scaups, teals, pintails, and other varieties, have used Big Lake Reservation, Ark., as a resting place and feeding ground this year. With its outlying sloughs this area is an important nesting and breeding ground for wood ducks and hooded mergansers. An increase in the number of wood ducks has been noted, more than 4,000 having been seen on the refuge this summer. Many egrets, herons, mourning doves, and woodcock use the refuge as a resting and feeding ground, and killdeer, sandpipers, and yellowlegs have also been numerous, as well as many species of insectivorous birds. Preliminary plans were made during the year that, if carried out, will make it possible to maintain the water in the lake at a satisfactory level.

UPPER MISSISSIPPI RIVER WILD LIFE AND FISH REFUGE

Progress in rounding out refuge areas and in broadening administrative control on the Upper Mississippi River Wild Life and Fish Refuge was made during the year. Some interruption of acquisition activities has occurred, but the indications are that a substantial part of the remaining lands desired will be acquired during the coming year.

Practically no restocking operations were undertaken during the year, though studies of former stockings were carried on to learn what can be expected from this work. The information at hand indicates that there is a splendid opportunity to carry on a broad and constructive plan of rehabilitation of the refuge area. From former plantings of beavers, there are now four well-established colonies of these valuable fur bearers within its boundaries. The animals appear to be doing well and additional introductions will be made early in the coming year.

Entirely satisfactory results from experiments with the waterfowl colony maintained on Lake Winona are not being obtained, owing to lack of complete control over the shore line. The increases in the number of birds maintained there have been reasonable, and Canada geese there mated this year for the first time since the refuge was established. Several mature mallard ducks were removed from the experimental pens to refuge territory in the river bottoms, where they were released during the spring with a view to having them rear broods of young under natural conditions. A small quantity of grain is being fed to hold the birds near the place where released.

Approximately the same inviolate sanctuaries were maintained throughout the refuge area as during the preceding year, and encouraging reports have been received regarding their effectiveness. Wood ducks appear to be making satisfactory increases throughout the entire length of the refuge, and each year more of these birds are found breeding there.

More muskrats were on the refuge and on immediately adjoining territory during the summer and fall than has been the case for many years, though a large number later perished as a result of the extremely low water throughout the Mississippi Valley, many animals starving during the winter. During the spring trapping season of 30 days, 728 permits were issued authorizing trapping on refuge lands, reports on which, though incomplete, indicate that approximately 23,000 muskrats were taken. Special permits continue to be issued for various activities that may be allowed on refuge lands without detrimental effect.

River pollution through the refuge area continues to present a vexing problem. Investigations made during the year by the Bureau of Fisheries and local agencies, as well as by the Biological Survey, disclose that the pollution in the river as far south as Trempealeau, Wis., is sufficient to be detrimental to fish life. Studies also show that sources of pollution on the river are to be found in city sewer systems and industrial plants and in oil discharged from river vessels.

Hearty cooperation continues between refuge employees and State officials. Patrol activities have been gratifying in that substantial increase in the number of apprehensions is shown over the preceding year. This does not indicate an increase in the number of offenders but is a direct result of the development of a more efficient patrol on the part of the refuge organization.

A marine railway with four steel trucks, constructed within the refuge at La Crosse, Wis., provides means of dry-docking the refuge boats for winter storage and repairs. Four ranger cabins were constructed at strategic points on the refuge, and outboard motors and small boats have been provided for the rangers as efficient and economical means of transportation throughout the refuge. During the

extremely low stage of water in the spring of 1930 a serious fire hazard prevailed, but the small refuge organization was able to control the situation effectively.

Progress on the purchase of refuge lands has been less rapid than in previous years, as tracts to be acquired are either being held at high prices or titles are so involved legally that acquisition other than by condemnation seems impossible. Land acquisitions were further complicated during the year when reports became current of the contemplated construction of numerous dams within the refuge boundary to raise the water level and establish a 9-foot channel on the upper reaches of the river. It is too early to anticipate the effect this would have on the development of the refuge, either in relation to the areas already purchased or on the value of the land to be acquired.

The total area of land under control, including accretions and acquisitions and also State-owned land not conveyed to the United States, is 106,823 acres. The many sloughs, ponds, and lakes intermingled with the lands under control contain an estimated area of 16,023 acres, making the total land and water acreage of the refuge 122,846 acres. This does not include any of the main channel of the Mississippi River within the exterior limits of the refuge, estimated to cover approximately 70,000 acres of water. Approximately 20,000 acres of land remain to be acquired before the refuge will be completed. The price of all lands purchased up to this time has averaged \$6.29 an acre. The funds authorized for this acquisition of lands, aggregating \$1,500,000, should be ample to complete the purchase of all tracts contemplated under the act.

ADMINISTRATION OF CONSERVATION LAWS

CHANGES IN REGULATIONS

During the past few years it has been found that conditions have been increasingly adverse to the welfare of the wild fowl. Water regions have been reduced by drought and drainage. The numbers of hunters have been constantly increasing. Improved roads and the widespread use of automobiles and motor boats have made it easier for gunners to reach regions where formerly the birds were unmolested. The devices used in hunting are increasingly effective. Undoubtedly, also, agricultural developments in this country and in Canada are materially limiting the breeding and feeding grounds formerly used by the birds. Studies made by the Biological Survey during the past three years also indicate that the wild fowl have not been holding their own and that additional measures for the protection of the ducks and geese must be adopted if their numbers are to be maintained.

In considering the availability of methods to insure the welfare of migratory birds, three measures that can be adopted are outstanding: (1) An increase in the production of the birds; (2) provision of resting and feeding sanctuaries for them in their migratory flights; and (3) restriction of the annual kill by hunters. Since results under the first two can be accomplished only after a period of years, the only immediate relief that seems feasible is to reduce the numbers of birds that may be taken during the hunting season. It is evident

that the sportsmen themselves must exercise further restraint if wild-fowling as a sport is to continue.

In line with this reasoning an important change was made in the regulations under the migratory bird treaty act just before the end of December, whereby the bag limits allowed hunters are reduced, effective at the beginning of the hunting season of this year. In the case of ducks the reduction is from 25 to 15 a day, and of geese, from 8 to 4 a day, and a possession limit of two days' bag is prescribed. These changes should lessen the aggregate kill on important winter concentration areas throughout the country.

During the coming hunting season the effect of the new amendments will be watched carefully by the Biological Survey. It is possible that additional restrictions may be found necessary to safeguard the birds—contingent upon the failure of these new regulations to accomplish the desired result. Among other methods that have received the consideration of the bureau are shortening the open seasons, establishing rest days, making further restrictions in the use of devices now allowed in the taking of ducks and geese, and limiting the artificial methods of luring birds within range of the shooting stands. If additional changes should be recommended, it will be only after the most careful study of all phases of the situation. In recommending the most recent changes the bureau was governed by this principle, and while extremists on both sides were in many respects inclined to criticize the action taken, it has been very generally appreciated that it was necessary for the bureau to proceed conservatively—not so rapidly as some urged and yet more drastically than many opponents of hunting restrictions desired—and the response has been very favorable on the part of hunters, conservationists, and the people generally.

ENFORCEMENT PERSONNEL

Though the difficulties of administration of the regulations under the migratory bird treaty act have greatly increased during the past 10 years, there has not been a proportionate strengthening of the enforcement arm. The increasing use of automobiles, motor boats, and airplanes to reach the hunting fields and to aid in such illicit practices as market gunning, night shooting, the snaring of ducks, and other violations has added immeasurably to the task imposed on the regular field force, consisting of only 25 United States game protectors.

The need for a force of game protectors, carefully trained, ably supervised, and sufficiently numerous adequately to enforce reasonable restrictions and thus to control the yearly kill of wild fowl is so important as to warrant its consideration as an emergency requirement. Each passing season records increasing contempt on the part of game-law violators for the Federal regulations designed to protect migratory birds. This deplorable condition is due to the general knowledge that in this matter the Federal Government is not fully equipped to carry out its obligations. Many law-abiding sportsmen and citizens who are interested in the preservation of American wild life are outspoken in their opinion that the Government is negligent of this resource, and they view the future of our migratory birds with dismay and discouragement.

It is to be borne in mind that the generous efforts of Federal and State Governments to establish wild-fowl sanctuaries and to eliminate and control disease and predatory creatures will prove futile if the illegal killing and sale of migratory game birds is not reduced far below the present totals. This can be accomplished only through the agency of an enforcement personnel numbering not less than three protectors where there is now one, and consisting of officers equipped with facilities to enable them to encounter the willful violator on somewhat equal grounds. Material help would be afforded if all persons would use their influence to encourage observance of the law, and would report violations without favor.

LAW VIOLATIONS AND PENALTIES

The handling and disposal of cases of violation of the migratory bird treaty act during the year are shown in Table 3. Of cases reported by United States game protectors and United States deputy game wardens, 93 were not forwarded for Federal prosecution because of lack of sufficient evidence, youthfulness of the accused, adequate fines in State court, or other satisfactory reasons. Federal judges imposed fines ranging from \$1 to \$2,700 and jail sentences in 14 cases. The aggregate of fines and costs was \$10,758.43. One defendant was sentenced to 1 hour and another to 1 day in custody of the marshal, and jail sentences of from 30 days to 6 months were imposed in 12 cases.

Plumage and migratory game birds of an estimated market value of \$3,000 were confiscated. The game birds in the majority of instances were donated to hospitals and other charitable institutions for use as food; the plumage was utilized for scientific and educational purposes.

The penalty of \$2,700, which was imposed in Federal court in Maine, represents the largest total of fines ever assessed at one time against an individual for violations of the treaty act. In December a man hunting in that State, aided by his employees, killed 90 eider ducks, on which, under Federal regulations, there is no open season at any time of year. Upon the defendant's plea of guilty, the court imposed a fine of \$30 for each eider duck killed.

Four cases involving hunting from an automobile were reported during the year, the first in which this practice has been outlawed by the regulations, and three of them have been successfully terminated. A number of complaints regarding the hunting of migratory

TABLE 3.—Cases of violation of the migratory bird treaty act disposed of during the fiscal year 1930, and cases still pending

Cases disposed of	Number	Cases pending	Number
Convictions.....	305	Pending from former year.....	454
Dismissals.....	80	New cases reported.....	303
Verdicts of not guilty.....	4		
No bills found.....	1	Total.....	757
Nolle prosequere.....	13		
Death of accused.....	4	Disposed of.....	407
Total.....	407	Pending at end of year.....	350

waterfowl from airplanes were received, and evidence was obtained against four persons and the cases were forwarded for prosecution.

Prosecutions have been instituted against 18 persons for hunting and trapping on the Upper Mississippi Wild Life and Fish Refuge in violation of the regulations under the act creating this reservation. During the year 9 new cases were filed and 4 were terminated by fines of \$25 each; 2 had previously been disposed of by fine; and the remainder are pending. Reservation wardens apprehended 61 persons who were violating State game laws on the refuge—45 in Minnesota and 16 in Wisconsin. These cases were terminated by fines and costs aggregating \$2,576.44. Nine persons found guilty were required to serve jail sentences, some of 30, some of 45, and some of 60 days.

Thirteen new cases were filed in Federal court for alleged violations of section 84 of the United States Criminal Code protecting wild animals, including birds and their eggs, on Federal refuges in general. Three cases were closed, two by fines of \$5 each, and the third by a jail sentence of 90 days.

CONSERVATION THROUGH EDUCATION

Despite the comparatively limited efforts the Biological Survey has been able to exert in the enforcement of Federal bird-conservation laws, by reason of its small force of game protectors, it has been active in disseminating information on the needs in the matter and has enjoyed the support and cooperation of many State conservation commissions, sportsmen's organizations, and individual conservationists. Game-law administration is thus not confined entirely to the apprehension and prosecution of violators, nor to the enforcement of other provisions of such laws. The dissemination of information of educational value may be of even greater importance in the scheme of conservation than are arrests and convictions. The United States game protectors and other field men of the Biological Survey constitute a most valuable educational force by reason of their varied personal contacts and the opportunities afforded them of addressing meetings of sportsmen and others, and of discussing at first hand matters affecting hunting conditions, game-law enforcement, game replacement, and conservation in general.

The press of the country has given wide publicity to statements issued by the bureau, and many of the sporting periodicals have reproduced in their pages the bureau's annual poster (No. 48-Bi) on open-season dates. One of these periodicals included by purchase from the Public Printer a copy of the poster as a supplement to each copy of a fall issue, the number thus purchased and distributed being larger than the total edition of the poster printed by the department for free distribution, the latter being chiefly for use in public buildings.

Among other publications issued during the year in the interest of bird protection and the conservation of wild-life resources generally were the thirtieth annual Directory of Officials and Organizations Concerned with the Protection of Birds and Game (Miscellaneous Publication No. 57); the annual bulletins on the game laws (Farmers' Bulletin No. 1616) and the fur laws (Farmers' Bulletin No. 1618), and, in the 1930 Yearbook of Agriculture, a statistical table (No.

585) comparing the numbers of hunters' licenses issued for the seasons 1926-27 and 1927-28, and showing the money returns therefrom to the States. The game and fur law bulletins give in a brief but concise form the provisions of both Federal and State laws concerning open seasons, bag limits, license requirements, possession, sale, transportation, and other provisions relative to migratory and upland game birds, game mammals, and fur bearers. These bulletins are widely distributed, it being the endeavor of the bureau to place them in the hands of individuals and organizations that can use them to the best advantage in the cause of conservation.

In addition to these publications and information disseminated through the press service of the department, the need for conservation measures as affecting wild birds and fur-bearing and other mammals has been brought to public attention through radio and other addresses by officials of the Biological Survey and by exhibits at sportmen's shows, and special articles for outside publication. A comprehensive discussion of wild-life conservation was prepared during the year in cooperation with the Bureau of Fisheries of the Department of Commerce, for inclusion as a new chapter of a privately published revised edition of a standard work on the conservation of the natural resources of the country. The first edition of this book had discussed the conservation of such other natural resources as land, water, minerals, and forests. The fact that invitation was thus extended to prepare the added chapter on wild-life conservation is significant of the trend toward increased recognition of the place of wild life in the general scheme of conservation and of the reputation of the bureau in this field. Other educational and reference articles prepared by members of the staff of the Biological Survey on invitation of outside publishers included several for encyclopedias on such subjects as game protection, wild-life reservations, and the work of the bureau in general.

Efficient administration of the bureau's regulatory and law-enforcement work can be accomplished only with the cooperation and support of all interested in wild-life conservation. Wherever this has been given during the year, it has aided the efforts made to create a sound public sentiment in favor of observance of the law, and this can be further supported only by evidence of willingness on the part of sportsmen and conservationists to adopt all restrictions necessary for the preservation of our migratory birds.

NEW SENATE COMMITTEE ON CONSERVATION

On April 17, 1930, there was appointed by the Senate a Committee on Wild Life Resources, consisting of five members, to investigate matters relating to the conservation and replacement of these resources, both land and aquatic, and to determine the most appropriate means to this end. Investigations were begun by the committee during the recess of Congress, and its recommendations will be made to the Senate, involving any necessary changes in legislation to carry out its conclusions. The committee has called upon the Bureau of Biological Survey for information, both in Washington and in the field, and the bureau has cooperated actively to facilitate its operations. The definite and comprehensive program of conservation to be evolved should aid materially in the perpetuation and preservation of our natural resources in wild life.

INTERSTATE COMMERCE IN WILD BIRDS AND MAMMALS

COOPERATION WITH STATES

No Federal prosecutions were instituted during the year for violations of the Lacey Act, which regulates interstate commerce in wild birds and mammals, but extensive investigations under the act were conducted by United States game protectors, many of them in response to requests received from State game departments for information regarding particular shipments. Violations of Federal law in this matter are predicated upon infractions of State law. The work of Federal officers thus becomes a valuable form of cooperation with the States. As a result of the activities of the field forces of the bureau a number of violations of State laws pertaining to traffic in pelts of fur-bearing animals were discovered, and considerable progress was made in discouraging violations, with improvement of conditions in some sections.

Investigations conducted by the Biological Survey at raw-fur centers resulted in furnishing State game-protection officials information regarding 5,249 shipments that apparently contained illegally taken skins. During the year the several States closed by prosecution 689 cases based on information originally furnished by the bureau, in which the aggregate of fines assessed was \$23,664.55 and the costs \$2,765.50, or a total of \$26,430.05.

Jail sentences were imposed against 10 violators as follows: 5 days, 1; 10 days, 6; 30 days, 1; 40 days, 1; 90 days, 1. In seven cases tried before a jury, verdicts of guilty were returned. One violator remitted more than \$3,600 to a State game department, representing the amount he had received for illegally shipped beaver skins.

Prosecutions involving violations of State fish and game laws exclusive of illegal shipments of pelts of fur-bearing animals were instituted in local courts in 25 States on information gathered by the field force of the bureau and transmitted to State game officials. Of these cases, 414 were successfully terminated, the fines and costs aggregating \$12,964. In addition 6 jail sentences, ranging from 30 to 90 days each, were imposed. This type of cooperation has proved invaluable to many of the States, which have reciprocated with assistance in obtaining evidence concerning infractions of the Federal laws and in other ways.

PERMITS FOR SCIENTIFIC PURPOSES AND PROPAGATION

The permit system adopted under the migratory bird treaty act is designed to allow reputable and qualified individuals ample opportunity for the scientific collection and study of migratory birds. The permittee is subject only to such restrictions as are necessary to prevent the waste or destruction of this resource through activities of such unqualified or unscrupulous persons as have no real scientific object in view or desire to use the permit for purposes not associated with the conservation or legitimate study of wild life.

Similarly, the department desires to promote and encourage the artificial propagation of migratory game birds by individuals and organizations, since in this manner the total supply of some of the most common and valuable species can be greatly increased and a legitimate industry developed. It is obvious, however, that the in-

dustry must be subject to some reasonable control if irresponsible individuals are to be kept from trafficking in wild game birds under cover of a Federal permit and in defiance of the regulation prohibiting sale or purchase of such birds. The business of propagation, sale, and distribution of game species artificially reared is worthy of support and encouragement, but the traffic in wild birds, which was chiefly responsible for the extermination of the passenger pigeon and a decrease in wild fowl generally, is a practice so destructive that it must be checked and repressed at every point. In order that authorities may have a means of distinguishing legitimate operations from illegal ones, individuals who wish to engage in the legitimate and commendable business of game propagation are required to record their qualifications and to report annually all operations under their permits.

The permit system under which migratory game birds may be captured and reared is not only an essential safeguard to prevent the disastrous exploitation of wild stock, but it affords protection to the properly accredited game farm as well. The regulations governing issuance of Federal propagating permits are only such as will accomplish these purposes with the least embarrassment and annoyance to the qualified individual. No fee whatever is charged, either for scientific or for propagating permits. The permit system adopted provides an excellent check on the activities of operators.

The total number of permits issued and outstanding during the year was as follows: Scientific collecting, 1,939; scientific possession or taxidermists', 367; propagation (possession and sale), 3,976. In addition, permits were issued to 98 persons for the trapping of stated numbers of waterfowl for breeding purposes. The reports submitted show that during the calendar year 1929 there were raised in captivity under permit 62,954 waterfowl of various species, of which 57,574 were mallard ducks and 3,734 were geese. Of the total number, 15,107 ducks and 432 geese were killed and sold or used for food, and 5,428 ducks and 2,285 geese sold for breeding purposes.

SEIZURE AUTHORIZATION NEEDED

Furs removed from the jurisdiction of one State and commingled with articles of interstate commerce in another usually are not subject to State seizure. The real solution of the problem of controlling illegal shipments, and thereby contributing to wild-life-conservation programs, seems to lie in an amendment to the Lacey Act that would confer on employees of the department engaged in enforcing its provisions the right to seize illegal shipments of the dead bodies or parts of wild animals.

IMPORTATION OF FOREIGN SPECIES

On May 25 the Bureau of Biological Survey completed 30 years of supervision of importation of foreign birds and mammals under the Lacey Act. Seldom has a Federal law remained on the statute books so long with so little change and with such uniformity in the policy of its enforcement. More than 10,000,000 birds and several thousand mammals have been imported since 1900, but during this time, so far as is known, no injurious species has obtained a foothold in the

United States. On the average about one mongoose a year has gained entrance, but these animals have either been destroyed or in a few cases have been confined for exhibition in zoological gardens. Several consignments of flying foxes have been denied admittance, and other species that might prove injurious have been introduced in small numbers and held in captivity for exhibition under close supervision.

Coincident with the close of the third decade of the operation of the Lacey Act, a new advance in conservation was made by the extension of the principle governing traffic in birds and game captured or shipped in violation of local laws of certain foreign countries. Under section 527 of the tariff act of June 17, 1930, any mammals or birds that are the object of special protection in foreign countries are prohibited from entry into the United States unless accompanied by a consular certificate setting forth that capture and shipment have been duly authorized in accordance with local requirements. This provision will restrict the shipment of certain rare species that are prohibited from export or that are obtained only on certain areas set aside as refuges or wild-life reservations. Heretofore the Biological Survey has had no way of preventing the entry of such consignments as they arrive at the ports of the United States, and the bureau has been subjected to criticism for its inability to prevent such traffic. In future it will be possible to cooperate more fully with foreign countries in this respect, and as the United States is probably the greatest market in the world for live animals and birds, the new legislation should aid materially in the protection of certain species.

The number of importation permits issued during the year was 1,205, a decrease of 49 from that of the preceding year. The inspection of shipments at various ports of entry decreased from 510 to 484. In addition 14 permits were issued at Honolulu, Hawaii, for the entry of 158 miscellaneous birds and 11 mammals. The first consignment of birds and mammals to cross the ocean by air arrived on the dirigible *Graf Zeppelin* from Friedrichshafen, Germany, at Lakehurst, N. J., on August 4, 1929, and included a gorilla, a chimpanzee, and 593 canaries. The total importation of birds exceeded that of last year and was the largest since the issuance of permits began. Of the total number, more than two-thirds were cage birds and more than half canaries. Game birds comprised chiefly Mexican quail, Hungarian partridges, and pheasants. The total number of all foreign birds imported was 825,736, of which 12,191 were without permit, many of them being brought in under declaration of passengers' baggage. Importations under permit comprised 562,980 canaries, 69,673 parrots, 90,124 quail, and 90,768 representatives of miscellaneous species.

MAMMALS

An unusual number of sea elephants was entered during the year. The Zoological Society of San Diego, Calif., obtained authority from the Mexican Government to capture four sea elephants and four fur seals on Guadalupe Island, Lower California, about October 1, and later in the year a shipment of four other sea elephants from the same island arrived for exhibition at Venice, Calif. The South Atlantic sea elephant was represented by two specimens, imported on September 23 and May 10, one of which was acquired by the St. Louis Zoological Gardens and the other by one of the large circuses.

Two gorillas were received during the year; one was brought in by airship and the other, making the fifth alive in the United States, arrived direct from West Africa about May 31. Considerable interest developed during the year in the importation of fitches for propagation in the fur industry and a few animals were brought in. On account of local restrictions regarding related species, these animals can not be imported into some States without special authorization. The high price of the breeding stock serves as a further deterrent to the importation of any considerable number of them.

So far as known, no injurious mammal was entered during the year, but considerable correspondence developed in regard to the importation of European hares. Application was made on December 16, 1929, for the entry of 400 for New Jersey or New York, but as no permit was issued, because of the damage that these animals have done in certain sections of these and other States, the shipment was stopped at Bremen, Germany. Correspondence also developed with the authorities in Michigan relative to preventing the introduction of these hares from Canada. European hares are now established in 10 counties of southern Ontario, but thus far have not gained entrance into Michigan.

The Bureau of Plant Quarantine and Pest Control of California has taken steps to guard against the introduction of species that may become injurious in that State, and to the same end cooperative arrangements by that agency and the Biological Survey have been made to guard against ill-advised importations of mammals.

GAME BIRDS

Hereafter, under the provisions of the new tariff act, game birds for propagation will be admitted free of duty. Though the loss to the Federal Government will be small, several of the State game departments will appreciate the change, as they have always regarded the payment of duty for importing birds for the public benefit as a hardship and an unwarranted expenditure of State funds.

Mexican quail.—Importations of quail from Mexico for distribution chiefly in Pennsylvania, Maryland, Virginia, Kentucky, Texas, Oklahoma, and Kansas were the largest on record, and for the first time the total number exceeded 90,000. The actual number, 90,124, was greater by nearly 3,000 than that of last year. Of these, 9,775 were entered at Brownsville, 61,922 at Laredo, and 18,427 at Eagle Pass, Tex., all being captured under concessions issued by the Mexican authorities to eight individuals, of whom four actually operated at the three ports named. The supervision of importations at the border as heretofore was handled through the Bureau of Animal Industry, and the inspectors issued permits, examined the shipments before entry, and furnished weekly reports on the number entered, with details of destination. No quail disease was reported during the season. The total number of quail imported since 1910 is now 613,311.

Hungarian partridges.—Interest has been renewed in Hungarian partridges during the past few years, and importations have increased steadily. The conservation commission of New York and the game commissions of one or two other States have been importing

these birds for restocking. The total number brought in during the year was in excess of 5,000.

CAGE BIRDS

The importation of cage birds as a whole suffered a serious setback on account of an outbreak of parrot fever late in 1929 and the prohibition of the entry of these birds after January 24, 1930. Not only was the parrot trade greatly reduced in volume, but because of the apprehension of the public the retail trade in other birds was curtailed indirectly in various ways.

Parrots.—The outlook last autumn indicated the largest importations of parrots ever made, beginning early in summer with consignments from Cuba, followed by yellow-headed parrots from Mexico and by Panama parrots and other large Amazons from tropical America. Just before the holidays, when the wholesale trade had passed its peak but many birds were still in the hands of retailers, a mysterious disease, commonly known as "parrot fever," was reported at Annapolis, Md., and was said to have been contracted from parrots recently imported from Colombia through dealers in Baltimore and New York. Wide publicity was given the matter by the press, and reports were soon received from a number of widely separated cities. In all, nearly 200 cases were reported, and a number of them proved fatal.

Through the activity of the United States Public Health Service, steps were at once taken to obtain all available information and to check the progress of the disease so far as possible. Although popularly termed "psittacosis," and generally so called in the press, the present outbreak differed in many respects from that of the original epizootic of psittacosis, which occurred among parrots in France in 1892. During the course of the outbreak in the United States no investigator succeeded in isolating the true *Bacillus psittacosis* in any case in man, but two investigators isolated a strain from parrots. The cause of the parrot fever was apparently a filterable virus. On recommendation of the Public Health Service, an Executive order was issued on January 24 prohibiting the entry of all parrots at any port of the United States or any of its possessions or dependencies, except under regulations of the Secretary of the Treasury. Under regulations issued February 3, the term "parrots" was defined to include members of the family Psittacidae, except macaws, cockatoos, and love birds, or parrakeets. The number of reported cases reached its maximum in January and February, and by the end of April the disease was practically at an end.

The Biological Survey made a careful investigation of the parrot importations of the fall of 1929 and whenever possible traced the origin of individual birds, but in only a few cases was it actually possible to trace the origin of shipments, as, for example, consignments of Panama parrots from Cartagena, Colombia, and certain double yellow-headed parrots from Mexico. Some of the cases in southern California and Hawaii were traced to a tourist steamer, which on a trip around South America took on infected parrots at Port of Spain, Trinidad, and to these birds were attributed cases at Los Angeles and Honolulu. So far as known no case of parrot fever was traced to any birds shipped from the Pacific coast of Central

America or South America, and practically all cases where identity could be established were limited to three or four of the commercial species.

This outbreak of parrot fever, unique in its wide distribution and rapidity of dissemination, has had far-reaching effects not only on quarantine restrictions but on the cage-bird traffic at the principal ports of the world. It apparently originated late in August in southern Brazil and in the Chaco, whence it soon spread to Buenos Aires and other ports. It appeared in Germany in November, and the first cases in the United States, apparently originating from birds that had arrived from northern South America in November, were reported early in December. Importation of the birds was prohibited by Los Angeles and other cities in this country, by one of the islands in the West Indies, by the Island of Guam, and by certain cities in Germany and in Austria. General prohibition of entry in the United States was contained in the Executive order, followed later by a sweeping prohibition in Canada, France, and England.

In the United States practically all cases in which the specific identity of the birds could be ascertained were confined to parrots commonly known as Amazons or to the gray parrot of Africa. The Amazons are natives of tropical America, and representatives of at least 35 of the 50 or more known species have been imported into the United States. Of these only the following are brought in in sufficient numbers to be considered of commercial importance: Double yellow-heads from Mexico; Cuban parrots from Cuba and the Isle of Pines; Panama parrots from ports in Panama, Colombia, and Venezuela; blue-headed parrots from southern Brazil; and white-headed parrots from Nicaragua.

Other cage birds.—Notwithstanding the embargo that prevented the entry of parrots during the last six months of the year, the number of cage birds imported compares favorably with that of previous years. Most of the grass parrakeets now handled by bird dealers are raised in captivity, and many are now produced in California. Of the numerous color phases of these birds that have been developed by crossbreeding, at least 8 have been imported into the United States, and 3 or 4 are now fairly common in the trade. Canaries were imported in large numbers for the holidays, but the trade as a whole was not satisfactory or profitable. In two cases large shipments of canaries suffered heavy mortality or were a total loss. These consignments arrived on successive trips of the same steamer, and the losses were finally attributed to poisoning by fumes from chemicals forming part of the cargo, which caught fire on board.

Among the more noteworthy of the rare and interesting birds imported, some of them for the first time, may be mentioned 45 birds of paradise, representing seven genera; 21 red-breasted geese (*Branta ruficollis*); 3 dwarf turtle doves (*Oenopopelia tranquebarica humilis*); 2 cassowaries (*Casuaris violeicollis*); 38 Kuhl's lorries (*Vini kuhli*), from Washington Island in the Pacific, the first ever brought into the United States; 1 blue-streaked lorikeet (*Eos reticulata*); African hawks and owls, including 1 hawk eagle (*Hieratus spilogaster*) and 6 African eagle owls (*Bubo africanus*); 6 dragon, or crested, starlings (*Galeopsar salvadorii*); 2 amethyst starlings (*Pholidauges leucogaster*); and 3 Venezuelan humming birds (*Chrysolampis mosquitus*).

CONSERVATION OF WILD LIFE IN ALASKA

The policy of recommending as few changes as possible in the regulations affecting game and fur-bearing mammals and game birds in Alaska has been pursued both by the Alaska Game Commission and the Bureau of Biological Survey, with the result that the hunting and trapping seasons for 1930-31 in the Territory were altered in only a few particulars to meet local conditions.

BIG-GAME ANIMALS

The amendment affecting the open season on large brown and grizzly bears, whereby residents of Alaska, except in designated areas and islands along or adjacent to the southern coast, are allowed to kill these animals at any season of the year, evoked considerable comment. The Alaska Game Commission had received numerous complaints of damage by bears to livestock and property, and the killing of a Forest Service ranger by one of these animals on Admiralty Island had greatly aroused the public in many other sections and brought about insistent demands for the removal of protection from these bears throughout the Territory. Both the commission and the bureau in dealing with the problems ordinarily arising in wild-life conservation have consistently followed the policy of giving the mammals and birds any benefit of doubt that might arise in regulatory adjustments. Evidence that human life and property are jeopardized in certain sections, however, has made it impossible to adhere strictly to this defined policy in the case of the large brown and grizzly bears in the greater portion of the Territory. It is to be borne in mind, however, that the exemptions apply only to residents of Alaska and not to foreigners or nonresidents. No change except in the reduction of the bag limit from three to two a season was made in the regulations affecting hunting of bears by other than residents.

The effect of the new regulations, both with respect to the conservation of the bears and the protection of life and property in the Territory, is being carefully watched, with a view to giving all possible safeguards to the bears without increasing the hazards to life and property.

Other changes affecting big game include closing the season on deer in parts of southeastern Alaska, slightly shortening the season in the portion of the Territory remaining open to deer hunting, and slightly lengthening the season on mountain goats, but reducing the bag limit from three to two goats a season.

Closed areas established by the new regulations include the Keystone Canyon areas paralleling the Richardson Highway, where all big game and birds are protected, and on the Steese Highway, where caribou are protected.

The privilege granted north of the Arctic Circle of taking caribou throughout the year was extended to include the region north of the Yukon River, in order that residents there also might obtain needed supplies of fresh meat. The caribou herds remain in excellent condition, and it is not deemed that the extension of the privilege to this additional area will be a menace to the continued welfare of the herds.

MIGRATORY BIRDS

The daily bag limits on ducks and geese were reduced to conform with recent amendments to the Federal migratory bird treaty act regulations, and the possession limit of 75 waterfowl heretofore prevailing in the Territory was reduced to 50, which, however, may not include more than 30 ducks and 8 geese.

FUR-BEARING ANIMALS

By an amendment to the regulations affecting fur-bearing animals, marten trapping is authorized this year for the first time since before the enactment of the Alaska game law of 1925. The seasons will run concurrently with those on other fur bearers in the various districts. Each trapper, however, is limited to a seasonal catch of 10 martens throughout the Territory, and it is required that the pelts be sealed as heretofore provided in the regulations for beavers and martens taken within or coming from outside the Territory.

Minks have shown sufficient increase to justify renewal of trapping in certain portions of Alaska where the season was formerly suspended. These include the Kenai Peninsula and most of the area north of the Arctic Circle. In response to requests of fur dealers and trappers, the mink season was closed in the regions comprising the drainages to Bering Sea and Norton Sound in the lower Yukon River region.

The spread of wolves and coyotes in the Territory led to an amendment to the regulations whereby the Alaska Game Commission may issue permits to qualified persons to trap these animals during the close season on fur bearers. To facilitate the enforcement work of the commission, however, traps set for these predators must be marked for identification.

Statistics compiled from reports of shipments of furs from Alaska show a total of 297,448 in 1929, which is 38,629 less than for the previous year. The skins in 1929, however, were valued at \$4,513,864 as against \$4,298,627 in 1928. The kinds of furs of which increased numbers were exported in 1929 include red fox, white fox, lynx, mink, and weasel. The notable decrease in the number of beaver skins exported in 1929—1,547 as against 32,712 for 1928—is to be attributed to the closing of the season on beaver in 1929, and this decrease nearly accounts for the total decrease in skins of all species exported.

PUBLIC INFORMATIONAL WORK

The informational work of the Bureau of Biological Survey is so conducted as to make available to the public pertinent information as developed in research work, conservation and law-enforcement activities, and pest-control operations. It consists, in addition to direct correspondence and the distribution of bulletins, leaflets, and other publications, of the preparation of technical and popular reports and other articles for official and outside publication, the delivery of addresses before conservationists and others in convention, the preparation of manuscript radio talks for delivery in person by officials or manifolded for broadcast by radio-station announcers, and the dissemination through the press service of the department

and otherwise of items on wild life for scientific, outdoor, and other periodicals, and for the daily and weekly press of the country. In addition, cooperative publication is encouraged by State and other agencies of some of the more lengthy reports on researches conducted by the Biological Survey on a state-wide or more restricted scale, including reports on the birds and mammals of States and other major areas. A further means of informing interested groups of the public on matters concerned with the native and other wild animals and birds of the country, and one widely employed by the bureau, is the use of motion pictures, lantern slides and other illustrative material, and special exhibits.

In all this work it is the aim to supply accurate and dependable information to counteract so far as possible the tendency to that form of exploitive writing ordinarily termed "nature faking." The wealth of data in its files, based on observations and investigations of field naturalists, biologists, and other scientific workers over a period approaching half a century, places the Biological Survey in a responsible position in these matters and involves extensive correspondence from individuals and organizations interested in the many phases of wild-life study, control, enjoyment, and conservation.

Technical reports on research in the geographic distribution and classification and relationships of mammals and birds are contained in the series of the North American Fauna of the Biological Survey, while other technical and popular reports are issued in the various series of bulletins, circulars, leaflets, and miscellaneous publications of the department. Miscellaneous Publication No. 49, issued early in the year, a Directory of Field Activities of the Bureau of Biological Survey, with a map, listed the field offices by State and locality within the State, indicated the nature of services there rendered or research conducted, and gave the name and designation of the official in charge. Details regarding the various other publications, special exhibits, and other informational data have been presented in connection with the discussion of pertinent subject matter in this report.

REPORT OF THE CHIEF OF THE BUREAU OF CHEMISTRY AND SOILS

UNITED STATES DEPARTMENT OF AGRICULTURE,
BUREAU OF CHEMISTRY AND SOILS,
Washington, D. C., September 6, 1930.

SIR: I present herewith the report of the Bureau of Chemistry and Soils for the fiscal year ended June 30, 1930.

Respectfully,

HENRY G. KNIGHT,
Chief of Bureau.

HON. ARTHUR M. HYDE,
Secretary of Agriculture.

INTRODUCTION

The Bureau of Chemistry and Soils is primarily a research and fact-finding organization whose activities cover a wide range of subject matter pertaining to land utilization, soil fertility, fertilizer resource development, and the utilization of agricultural products of various kinds. The bureau has for its objective the gathering of information and the determination of scientific facts and principles through experimentation and research to the end that these may be applied to the conservation and utilization of American soils and to crop-production and crop-utilization problems of regional and national importance.

The bureau is actively prosecuting investigations and research on 559 subprojects under 131 major lines of inquiry recognized as projects. These major lines of inquiry to all intents and purposes are continuous or at least cover a period of years, whereas the subprojects, which represent the detailed activities of the bureau at any given period, have time limits placed on them, and when completed they are succeeded by others usually in the same line of inquiry.

In the main the appropriations are made to the bureau for the purpose of attacking specific problems, the solution of which is of interest to the business of agriculture, and has, therefore, a utilitarian objective. Direct attack upon some of these problems, however, in the absence of essential fundamental knowledge would be wasteful of funds and energy. Search for the fundamental knowledge is therefore often necessary and it may lead the investigator into the realms of pure science, where a foundation is laid for the logical attack and final solution of the problem under consideration. Such a method of attack requires careful, thoughtful planning, the devel-

opment of skilled technic, intelligent and discriminating analysis of results, and ability of a high order to make the necessary practical applications.

It is the policy of the bureau to encourage the development of more research in the realm of pure science, always, however, with the definite objective of solving some practical problem. The results of such research may have a very wide application in fields far removed from agriculture or industries based on agriculture so that in such cases the bureau contributes materially to the advance of science in general. Research for research's sake without regard to practical applications in the fields assigned to the bureau has no place in this organization.

Much of the work of the bureau is carried on in cooperation with the States and in a few instances with industrial groups. For a period of more than 30 years the soil survey has been conducted on a national scale. This work has been in cooperation with the several States usually on a basis whereby the States have shared expenses equally with the bureau. Soil-erosion work is now carried on in cooperation with five States. Much of the soil-fertility work is in cooperation with the agricultural experiment stations of the several States, and wherever it seems practical and desirable other research is carried on cooperatively. Very close contacts are made with industrial groups utilizing agricultural materials or manufacturing finished products primarily for use on the farm.

The interest of the farmer should not terminate with the production of his crops, but he should be in position to follow his products through to the ultimate consumer in order that he may intelligently adjust his production to the demands of the market. The bureau, therefore, should function not only as a research agency to increase efficient unit production but it should also be in position to follow the products of the farm through the industrial processes that make use of agricultural products.

The research activities of the bureau should result in a more economical utilization of farm products in the manufacture of articles of commerce and the production of more uniform final products, thus benefiting the farmer and the ultimate consumer. The widening of markets for farm products through the development of new channels for their industrial utilization is one of the most important functions of the bureau. Painstaking research and the application of the results to the problems of industry is the only way that this may be brought about. New industries have arisen during the past few years which use as their raw materials the products of agriculture. The utilization of waste and residue for industrial purposes is a subject which is receiving careful attention, and the possibilities in this field appear to be great. Numerous examples may be cited where waste has been converted into valuable commodities, but the greatest agricultural waste, the crop residues, consisting of stalks, straw, hulls, etc., are still awaiting wide industrial uses. If the history of the past is to be repeated the waste of to-day will become important raw material for the use of industry to-morrow.

More than one-half of the agricultural area of the United States has been surveyed by the bureau. Until we have a better knowledge of the soil resources of the United States, land classification on an

intelligent basis and effective land utilization based on sound principles are practically impossible. Furthermore, much of the soils work of the bureau and of the States is based on the soil survey. It is encouraging to note that there is an increasing interest on the part of the States in the whole subject of land classification, soil conservation, and soil fertility, which makes this field of work exceedingly important.

Probably no industry depends more on research for its prosperity and its economy of operation than does the fertilizer industry. Research in this field aimed at economy of production reflects direct benefit to agriculture in the form of cheaper and more satisfactory sources of plant-food materials. Such researches are primarily functions of the Federal Government, since they are directed to the development of a more efficient national agricultural program.

The nitrogen-fixation industry in the United States seems to be making satisfactory progress. The phosphate industry has been very well stabilized, based on well-known practical methods, but new methods are being developed and put into use which will have a direct bearing on the concentrated-fertilizer industry. America has rather large sources of potash, but most of it is locked up in a form that can not readily be made available. The bureau is prosecuting special investigations in an attempt to perfect commercial methods for extracting potash from potash-bearing silicates, which are widely scattered over the country.

The use of fertilizers in agriculture is increasing, and it is highly important that this country not only have sources of supplies of the raw materials, potash, phosphate, and nitrogen, but also that the most economical methods be developed for their preparation in satisfactory forms for use on the land. The increased use of mineral fertilizers, the large increase in the use of mechanical power replacing animal power, and the possibility of making larger use of agricultural residues in industry raise some very important questions in regard to the soil organic matter and its maintenance. These problems are being given careful attention by the bureau.

There has been a marked increase in the number of departmental publications from this bureau during the past fiscal year. A total of 60 departmental publications has been published from July 1, 1929, to June 30, 1930. This number includes 48 soil-survey reports, 8 technical bulletins, 3 circulars, and 1 miscellaneous publication, which represents a very marked increase over the number of technical bulletins published last year, and an increase from 40 to 48 soil-survey reports. Four articles by members of this bureau, published in the *Journal of Agricultural Research*, are not included in the 60 publications mentioned above.

The soil-survey reports published during the year contained descriptions and maps of soils in 20 States and cover a total of millions of acres of agricultural lands. The soil surveys are becoming increasingly helpful to farmers as practical handbooks for working out local agricultural problems.

The technical bulletins published in 1929-30 present valuable information on soils and chemical and technological research along agricultural lines.

In addition to the departmental bulletins, 109 articles by scientific workers of the bureau have been published in technical and scientific journals, magazines, and other publications, thus furnishing the public and other scientists the latest information on the progress of various lines of research carried on by the three units of the bureau.

The bureau has greatly increased its output of information to the press within the past two years and through its editorial office has prepared releases of timely interest on the varied work of its units. It is constantly cooperating with the press service and the radio service of the office of information of the department in supplying information to the public and to the special or regional groups to which it might prove of service.

In addition to the large number of departmental publications and the informational service supplied by the bureau, there have been sent 42,000 letters of information in reply to inquiries received in the various offices of the bureau's three units during the past fiscal year.

A number of leaflets and circulars are being prepared or printed with the purpose of supplying much of the information which the bureau has hitherto sent out in letters.

CHEMICAL AND TECHNOLOGICAL RESEARCH

The chemical and technological research of the bureau has as its main object the more complete and profitable utilization of products of the farm, ranch, and orchard. Such researches are at times abstruse and fundamental, but usually they have either directly or indirectly an economic outlook. The results have an important relation to the conservation of our national wealth and energy. Most people look upon conservation as the hoarding up, the storing away, or the holding in reserve of our forests, agricultural lands, and oil supplies, but a far more important conservation in the economic life of a nation is that which aids in the most complete utilization of its products. For instance, from a purely economic standpoint it is more important fully to utilize the hide of a farm animal in some form of leather than to produce an additional animal; it is more important fully to utilize the oil, the protein, and the coarser parts of wheat than to grow an additional bushel of wheat per acre; it is more important to utilize the cull fruit or vegetable, the undersized, the oversized, the odd-shaped product which is not acceptable in ordinary commerce, than to develop new orchards and produce additional yields of fruits and vegetables. For in such farm by-products, as they are sometimes called, a part of our national wealth is spent, represented by the fertility of the soil, which in a final analysis is an all-important factor in our national resources and in our national existence.

CARBOHYDRATE INVESTIGATIONS

CANE SIRUP

A more complete utilization of cane juice for sirup production and the adjustment of quality in relation to market requirements are of vital interest to the producers. Investigations of methods of manufacture of cane sirup from last mill juice have been continued,

and a procedure has been worked out whereby a blending sirup of satisfactory quality may be produced from last mill juice at reasonable cost. This information has been placed at the disposal of a number of sirup producers, and it is expected that it will be put to commercial use.

Investigation of the cause and remedy for "swells" in canned cane sirup was continued. This type of swells has caused severe losses to the cane-sirup industry. By preliminary "incubation" at elevated temperature it was possible to distinguish in advance sirups having a tendency to produce swells.

Research on the origin of the flavor of Barbados sirup has disclosed important information, and there has been isolated from this sirup an anaerobic bacterium which produces the typical Barbados flavor when introduced into domestic sirups. This flavor was in some cases much more pronounced than that of Barbados sirup, so that the next problem is to determine the conditions necessary for controlling and producing the exact degree of flavor desired.

Work on the standardization of cane sirup, which is produced on about 275,000 individual farms, is being continued.

CANE SUGAR

Investigation of the basic principles of clarification of cane juice and application of this information to the solution of problems of importance to the cane-sugar industry were actively continued. In work of this kind lies the greatest opportunity, aside from increase in the sugar content of the cane, to increase the net yield of sugar and thus offset to some extent low prices resulting from excessive production. Poor quality of raw sugar is exhibited in various ways, but one of the most tangible is the poor filterability of the raw-sugar melts in the refinery. Various methods of fractionating the extraneous material were used, and there were established maximum and minimum limits within which this material had adverse effect. Information regarding the composition of this material was also gained.

The work on methods of utilization of sugarcane in Louisiana concerned specific Louisiana problems pertaining especially to production of direct-consumption sugar on the plantation and production of molasses of improved quality. Here again clarification of the juice is the basic factor. Flavor and quality of molasses of table grade are also adversely affected by frost, with resulting financial loss. Consequently a special procedure which could be used for clarification of juice from frosted cane would be of very great value. Efforts were directed along this line, and important advances were made.

BEET SUGAR

A satisfactory method for automatic control of pH in second carbonation of sugar-beet juice was devised and indications given whereby this information could be applied to third saturation of the juice.

The low price of sugar during the last few years has resulted in increased discrimination as to quality. Cooperative investigations

were conducted at several beet-sugar factories with respect to use of activated carbon for removing undesirable nonsugars. Some experiments were also made on use of other reagents for increasing elimination of nitrogenous compounds in the diffusion juice at the beginning of the beet-sugar process. Results to date have indicated modifications at several points in the present beet-sugar process, including also use of a small proportion of activated carbon, whereby the quality of beet sugar can be greatly improved at a reasonable cost.

MAPLE PRODUCTS

The principal work done on maple-sirup color standards during the year was the improvement and accurate definition of the standards, thereby correcting a rather demoralizing condition which has existed during the past few years as a result of variation in color standards from different sources. In many cases the variation has amounted to one and even two grades, which may be a serious matter to the producer in selling maple sirup.

The original color standards used in the industry were based on caramel made from refined sugar. It was found that, even with the most carefully controlled technic, the color varied considerably, due to slight variations in the quality and nature of the nonsugar contaminants which are always present to some extent even in the highest grades of refined sugar. The color standards were evaluated accurately on a spectrophotometric basis and a method devised whereby accurate and constantly reproducible caramel solutions can be made. Master color standards were furnished marketing organizations and State departments of agriculture and marketing bureaus in the various maple-products States. On the basis of the master standards these organizations prepared a large number of color-standard sets for distribution to individual producers throughout the States in question. This work is being continued in an effort to devise suitable and inexpensive permanent color standards.

HONEY

Improvements have been made in the method of determining the diastase value of honey. It was found that the diastase value varies considerably with the floral source, orange and alfalfa honeys being naturally deficient, whereas certain other types, such as buckwheat and sage, showed unusually high values. In general, the darker honeys showed a higher diastase value than the lighter samples. An endeavor is being made to classify domestic honeys more specifically, taking into account their variation in composition in relation to variations in properties. When such a survey and classification as is under way has been completed, the suitability of honeys for certain purposes will be much more apparent. As a part of this program an investigation of the colloidal constituents of honey has been started, representing an entirely new point of view in approaching this problem. It is believed that constituents of colloidal character not only are primarily responsible for the dark color of many honeys but are also concerned in the decomposition reactions and excessive discoloration apparent on heating honey.

MILK SUGAR

Investigation was made of the behavior of lactose in several kinds of candy and its possible suitability and advantage as one of the recognized ingredients thereof. This work was undertaken in the interest of the dairy-products industry, at the suggestion of, and in cooperation with, the Bureau of Dairy Industry. At present large quantities of sweet whey are wasted or inadequately utilized. The results so far obtained indicate that lactose, when used in certain proportions, is a valuable ingredient of hard candies, especially in that it tends to reduce hygroscopicity, which is one of the great problems in handling such candies.

SWEETPOTATOES

Experiments to ascertain the suitability of sweetpotato starch for commercial use were continued, and results so far indicate that commercially satisfactory conversion products can be made from it. Means were also devised whereby sweetpotato starch can be refined to a higher degree of purity. An investigation is now under way with reference to the possibility of more effectively utilizing cull sweetpotatoes so as to avoid the loss of any constituents. This study will be undertaken with the idea of using the culls for starch and starch-conversion products, for vinegar, and for cattle feed.

MISCELLANEOUS INVESTIGATIONS

About 50 wild domestic plants have been subjected to a preliminary chemical examination with a view to devising means for their utilization. One of the most interesting results obtained was with wild licorice. The glycyrrhizin content of this plant suggests the possibility of producing our own supply of licorice in this country. Investigations on corn sirup and corn sugar will be continued; also on the wider utilization and closer standardization of sorgo sirup.

CROP-CHEMISTRY INVESTIGATIONS

With the object of improving the quality of that part of the food supply of the United States which is derived from crops the bureau is engaged in scientific study of the factors affecting the quality of American crops, in order to discover such modification of present farming practices as will aid in effecting improvement.

During the past year experiments have been conducted on plots at the Arlington Experiment Farm, Rosslyn, Va., in which the effects of sodium nitrate fertilizer in increasing the protein content of wheat were compared with the effects of various modern synthetic nitrogen compounds. So far the results have been the same, although no final results can be reported, as the growing of wheat in the plots is being continued.

Experiments have also been continued to determine the extent to which the phosphorus content of wheat can be increased by special fertilizer applications. The influence of acidity and other factors on the absorption of phosphorus by wheat plants has been investi-

gated, and data obtained to guide the applications of fertilizers to the wheat plots on the Arlington farm.

Methods of determining the manganese content of cereals and the absorption of manganese by growing plants have been extensively studied, and several improvements have been made in existing methods. It has been found that ammonium persulphate can advantageously be used in determining manganese in plant materials. The absorption of manganese by young plants has been studied and some of the principles governing absorption worked out.

A number of culture experiments with wheat seedlings have been conducted, and certain principles governing absorption of nutrient elements have been formulated.

Much analytical work has been done in determining the inorganic constituents of the wheat in which lignin is also being determined. It has been found that relations can be traced between the amounts of several constituents and the nitrogenous fertilizers added, which also affect the lignin content.

As great interest is being shown in the soil-reaction preferences of plants of both horticultural and agricultural significance, most of the work under this project has consisted in furnishing information to the public. A manuscript has been prepared for a bulletin in which the questions most frequently asked have been answered, and the most elaborate list of soil-reaction preferences of plants yet compiled has been included.

FOOD RESEARCH INVESTIGATIONS

CITRUS BY-PRODUCTS

The possibilities of wider and more profitable utilization, in Florida, of citrus by-products, particularly those of grapefruit, were investigated. Visits were made to ascertain the possibilities of by-product utilization in connection with grapefruit canneries in California and Texas. Special problems of the canning industry were studied for the benefit of canners and orchardists in these States.

The production of pectin, grapefruit oil, and cattle food from the waste of grapefruit canneries was studied. The canned grapefruit industry of Florida has been developing rapidly. It is estimated that had it not been for the setback caused by the Mediterranean fruit fly, more than 25 per cent of the Florida crop would be canned. A very timely investigation of the possibility of utilizing the waste from grapefruit canneries has been undertaken. This project is of special significance owing to the fact that the waste from such canneries must undergo treatment in order to destroy the eggs and larvae of the fruit fly.

PRESERVATION BY FREEZING

With increased facilities for the storage and distribution of food products at greatly reduced temperatures, the question has arisen whether many of the fruit juices which undergo deleterious changes on sterilization can not be satisfactorily prepared by freezing. The greatly reduced cost of solid carbon dioxide (known commercially

as Dry Ice or Nu Ice) prompts the investigation of the possibility of preparing, shipping, and distributing fruits and fruit juices to the housewife in a frozen condition. This investigation is progressing, and there are now in storage several hundred packages of citrus and other products which have been frozen at temperatures ranging from 30° to 50° F. below zero. The possibilities of the different types of packages are being investigated and methods devised for packing the products in inert gas and under high vacuum. It is felt that the next few years will show a marked change in food distribution, with frozen foods playing a very important part in household economy.

The following frozen products have been prepared and are now in storage for observation and study: Orange juice, grapefruit juice, lemon juice, pomegranate, Logan blackberry, pineapple, and several blends of the foregoing. In addition, orange slices and grapefruit hearts in juice and sugar sirup, pineapple, banana, and avocado have been frozen and stored. These products have been packed in crown cap bottles, friction-top cans, and jars sealed under vacuum. In addition to these experiments, some of the products were treated with carbon dioxide prior to packaging.

DEHYDRATION AND SUN DRYING

Studies on the sulphuring of apricots and peaches have been successfully advanced. The fruit was prepared and in most cases picked by men in the field and after sulphuring was dried in the sun in the manner prescribed by commercial dry yard practice. When partly dried it was stacked and the drying completed. The moisture content was reduced to about half that usually found in growers' stock. This was done to keep the samples in as fine shape as possible for the work which was to be carried out later in the year.

It was found that while there are some exceptions, the general trend of grade is correlated with sulphur dioxide retention. The higher the content of sulphur dioxide the better the appearance of the sample, but there is no doubt that samples running around 80 grade are satisfactory in appearance and that it is unnecessary and undesirable to make the fruit translucent if doing so requires excessive sulphur dioxide.

It seems there is little difference between the 2, 3, and 5 hours of sulphuring, as far as the quality of the fruit is concerned.

As there is practically no difference shown in the 100° , 110° , and 120° F. temperatures, the best quality of fruit, taking sulphur content into consideration, was sulphured in 3 per cent concentration of sulphur dioxide, two to three hours at 110° to 120° .

The 100 samples of dried peaches obtained as a result of this work had been given about the same treatment as the apricots. The peaches, however, do not retain the sulphur dioxide to the extent that the apricots do. The most favorable concentration for peaches was 5 per cent. The most favorable time was 3 hours, the 5-hour samples being inferior to the 3-hour. Temperatures from 100° to 120° were most satisfactory.

A study is being made of the relation between the total contents of sulphur and of sulphur dioxide in dried apricots and peaches,

sulphured and unsulphured. Cooking experiments are under way, designed to ascertain whether there is a considerable loss in sulphur dioxide during cooking, and whether this loss, if any, is due to volatilization of the sulphur dioxide or to its oxidation.

EFFECT OF ETHYLENE ON FRUITS AND VEGETABLES

It has been demonstrated that in seasons when pears do not soften readily they can be treated economically with ethylene gas and are then ready for canning. The process usually eliminates sorting, except that which normally occurs on the preparation tables. It has also been demonstrated during the past year that pears may be treated under canvas with satisfactory results. Tests have shown that the varieties of apricots which tend to mature unevenly—one side softening while the other remains hard—can be harvested and softened by means of ethylene treatment so that the fruit will soften uniformly and its availability for canning be greatly increased. Actual cannery tests demonstrated that the proportion of soft fruit is increased and that of hard green fruit materially decreased by this treatment.

Work with tomatoes has shown that in all cases the treated fruit colors at a somewhat faster rate than the untreated fruit kept at the same temperature and not in direct sunlight, also that there is a slight but constant decrease in acidity of the juice of the treated sample.

A total of 18 samples of celery were treated with ethylene; they included Utah Chinese, a self-blanching Long Top, White Plume, and others. In all cases the treatment had but little effect. Where the type is self-blanching, an unimportant change occurs, but where the green celeries are treated, no effect is obtained, and these are the types that might be greatly benefited.

FOOD SPOILAGE AND DETERIORATION

The commercial preparation of mayonnaise is a rapidly growing industry, the value of the product in 1928 being estimated at \$16,500,000.

The effect of different grades of eggs and egg products on the quality of mayonnaise was studied. Bacterial counts on the samples of egg yolks showed that even those of fresh eggs contained fairly large numbers of microorganisms. While the original egg yolk contained large numbers of bacteria, the resultant mayonnaise gave fairly low bacterial counts. This study showed that in the manufacture of mayonnaise large numbers of the microorganisms causing the decomposition of the egg yolk were killed during the preparation of mayonnaise.

Samples of egg yolk were stored in such a way as to determine the effect of the following conditions: (1) Oxidation, (2) enzymic activity, and (3) bacterial decomposition. These experiments demonstrated that bacterial activity alone increased the time of the consistency test, whereas oxidation and possible enzymic activity also had a similar effect.

The pin-spot molding of shell eggs which causes an annual loss of thousands of dollars has been investigated. Experiments were made to determine the conditions which contribute to the development of the external pin-spot mold. The eggs were treated as follows: (1) Washing, (2) oil processing, (3) packing in moist flats and fillers, (4) sweating, (5) packing in green shook, and (6) no treatment of normal eggs. The eggs were examined from time to time and finally removed after six months storage. None of them showed the development of pin-spot mold except those packed in green wood cases.

A method has been devised for the oil coating of eggs under vacuum. This process results in a somewhat better seal of the shell by the oil than results in those dipped at room pressure. Determinations of the loss in weight of oiled and unoled eggs have shown that the oil coating of shell eggs markedly inhibits shrinkage under ordinary cold-storage conditions. Application of the oil by the vacuum method results in even less shrinkage than in eggs dipped under atmospheric pressure.

PRESERVATION OF FOOD PRODUCTS

Studies of the waterless canning of nonacid vegetables have been continued by the experimental canning of whole-grain sweet corn. Several cases of the product have been canned under different test conditions and examined for vacuum and flavor. Experiments have shown that in the preparation of corn by this method the most practical length of scalding is approximately 10 minutes and the best method for seasoning is the addition of salt in the form of a saturated brine.

The fermentation of turnips into sauerkraut was tested in the laboratory and found entirely practical. Sufficient sugar is present in the ordinary turnip to support fermentation to the desired acid content. The product is pleasing in flavor, and, aside from general appearance, is not unlike good cabbage sauerkraut.

FERMENTATION AND HEATING OF FARM PRODUCTS

Laboratory heating experiments were conducted with moistened salted and unsalted alfalfa hay. No heating was recorded under anaerobic conditions, but heating occurs in the presence of air. Thirty per cent moisture was found to be the optimum moisture content for microbial heat production. The addition of 5 per cent salt failed to prevent microbial heating. However, salting was found to induce considerable delay before heating started, depending on the relation of the amount of salt to the total moisture. The addition of 2 per cent salt prevented bacterial growth but failed to prevent mold development, although the growth of the mold was considerably delayed. Results would indicate that the prevention of molding and spontaneous heating of hay by the addition of salt would only be efficient under such conditions as would allow for drying below the critical point for mold development within the short period of delay caused by the salt.

MILLING AND BAKING INVESTIGATIONS

A billion dollars worth of cake is made annually in this country from 5,000,000 barrels of flour. Recent work has shown that as good, and often better, cake can be made in the laboratory by mixing all the ingredients together and at once than by following heretofore approved directions which call for creaming the fat and sugar first and then adding the other ingredients. This, if found practical in a commercial bakery, will simplify cake baking, save time and considerable labor, reduce the cost, and no doubt increase consumption.

The early stages of rancidity in rice and rice-mill products has been studied. This is preliminary to the work which is being carried on in the study of rice bran and rice polish, which readily turn rancid. One method of treating these products has been to incorporate with them some vehicle like molasses and to subject the mixture thus prepared to a high pressure (about 1,000 pounds). In this way it is believed that as a result of excluding the air these perishable products will not become rancid so soon. Furthermore, the bulk of these products is materially lessened.

Flour obtained from germinated grains (chiefly legumes) has been added to the extent of 2 per cent to wheat flour and a greatly improved loaf produced. The results indicate that the length of time of germination exerts a material influence on the quality of the loaf. Considerable work is still required to determine the optimum germination period needed to produce the best effect, as well as the optimum amount of material which should be added to the flour.

PHYTOCHEMICAL INVESTIGATIONS

A study of the progressive changes in the waxlike coating on the surface of the apple during growth and storage has been brought to a successful conclusion.

With the particular object of determining the progressive changes which occur in the composition of this waxlike coating, analyses were made of summer, fall, and late varieties of apples at several stages of growth and after storage at 32° F.

Results of these analyses, expressed in milligrams per 100,000 mm. of apple surface, indicate that there is an increase in ursolic acid, oily fraction, and total ether extract throughout the ripening period and during storage.

In general, larger quantities of ursolic acid and total ether extract are deposited on the shady than on the sunny side of the same apple, whereas there seems to be no appreciable difference in quantity of oily fraction. As a result, the percentage of oily fraction in the total ether extract is lower on the shady side.

The change in physical properties which the waxy coating of apples undergoes as the fruit ripens may be an important factor in the formation of certain odorous constituents. A decrease in permeability might readily restrict the exchange of carbon dioxide and oxygen to such an extent that an intercellular gas condition would be reached similar to that found by Thomas in which certain concentrations of these gases resulted in the formation of abnormal quantities of acetaldehyde.

A preliminary study of the permeability of apple membranes (cutin and epidermis) to water has indicated that considerable variations exist among varieties.

During 1930 supplies of raw cutin, oily fraction, and ursolic acid have been collected for future investigations.

CHEMISTRY OF PLANT PRODUCTS

A study of the acid of the blackberry, isocitric acid, was made with the object of establishing the identity or nonidentity of the blackberry acid with synthetic isocitric acid. It was found that the synthetic acid corresponds to the inactive form of the natural acid. The results of this investigation have added to our knowledge of fruit acids and will be of special interest to the food analyst.

Analyses were made of 15 samples of Indian foods for moisture, ash, crude fiber and fat, insoluble solids, pectin, etc. (This work was done in collaboration with the carbohydrate division which is making an investigation of the carbohydrates in Indian foods.) A complete analysis was made of the ash of *Camassia esculenta*, which gives promise of having commercial possibilities.

An investigation of the organic acids in 15 samples of honey of different floral varieties from different parts of the United States (including one from Hawaii) was completed. The volatile acids of honey are small in quantity and were found to consist mainly of formic and acetic acid. Many of the samples contained traces of succinic acid, and malic and citric acids were found in all. Only of tulip honey was it possible to isolate the acids as esters and to distill the ester fractionally. In the case of orange honey it was found possible to isolate and identify methyl anthranilate, an ester of delightful odor, to which the aroma of orange flowers is largely due.

A chemical investigation of green vegetables was undertaken primarily because a question arose as to the desirability of spinach as a food on account of its oxalic acid content. Therefore, the work began with an investigation of the acids of spinach. Only one sample of spinach thus far has been examined, and it was found to contain 0.32 per cent of oxalic acid (in the form of salts) in the fresh vegetable, in addition to citric acid and a small amount of a malic acid.

A similar investigation of broccoli, is in progress, and results have already shown that this vegetable contains much less oxalic acid than does spinach. A complete analysis of broccoli is in progress.

At the request of the Office of Cereal Crops and Diseases of the Bureau of Plant Industry, an investigation was started on the organic acids of wheat seedlings. The predominating nonvolatile acid in a water extract of wheat seedlings was found to be l-malic acid. Considerable quantities of aconitic and citric acids, a small amount of malonic acid, and a trace of oxalic acid were also isolated.

The effect of arsenical sprays on the composition of oranges is being studied. Heavily sprayed oranges were found to contain from one-seventh to one-fourth of the normal free acidity of the unsprayed fruit. Heavily sprayed fruit was also found to be lower in sucrose, although the total sugar was not appreciably affected.

Overspraying seriously lowers the market value of the fruit. A study is being made of the effect of processing oranges in compliance with the department's requirement for shipment from certain sections of Florida. It was thought that the treatment might cause some inversion of the sucrose present, but none has been detected. Some changes taking place in oranges in cold storage are also being studied in connection with the work on the effect of arsenical sprays and of processing.

INDUSTRIAL FARM-PRODUCTS INVESTIGATIONS

HIDES AND SKINS

Under present conditions it is necessary to buy from foreign sources about one-half the hides and skins used by our leather industry, yet each year in this country millions of dollars worth of hides and skins are lost because of wasteful practices in handling them before they reach the tannery. Conservation of these essential leather-making raw materials is the primary object of the work under this project.

SKINNING AND CURING HIDES

More than 500 personal calls on butchers and dealers have been made by the bureau's hide experts. Methods actually employed in skinning and curing have been noted, and ways to improve them and eliminate waste have been explained and demonstrated. The practical value of the work is demonstrated by the fact that requests are being received from hide dealers to have our hide specialists call on their customers from whom shipments decidedly off in quality are being received. Some butchers have almost entirely abandoned the use of old, bloody salt, and they are receiving more for hides and skins as a result of following the instructions and advice of the hide specialists. The indifference of many producers is caused by lack of standardized grades. Work is being done in cooperation with the Bureau of Agricultural Economics in acquiring data on which to base grade descriptions and specifications.

SALT STAINS

Investigations on salt stains, which cause especial damage to the grain of calfskins, have been continued. Another type of damage known as "reddening" is also being studied. Using nearly sterile, well-salted skin and a red, salt-tolerant organism isolated from a salted hide, a bright red discoloration strikingly like the pink or red color frequently occurring on frigorifico, or South American packer hides, has been reproduced. This reddening of hides and skins has been the subject of much controversy between sellers, buyers, and ocean carriers. The above experimental result is but preliminary, and much remains to be done to establish its identity, but there is evidence that the organism causing reddening occurs only in certain salts.

TANNING MATERIALS

Means to conserve the rapidly diminishing domestic supplies of tanning materials and the development of new sources of material and of more economic processes of tanning are being investigated. Samples of many trees obtained from different foreign localities by the office of forest pathology, Bureau of Plant Industry, have been examined for tanning content. Fifty-two samples of *Castanea crenata* and eight samples of *C. mollissima* have been obtained so far. Both the bark and wood of these specimens are being examined for tannin. The results indicate that the tannin content of the wood of these *Castanea* is as high, if not a little higher, than that of American chestnut wood. Other properties of these materials, including especially the quality and color of the leather made with them, remain to be determined.

Specimens of Chinese chestnut trees grown on the department's experiment farm at Bell, Md., have also been examined for comparison of their tannin content with that of the American chestnut tree and for the purpose of correlation of analyses of these trees with analyses of the upper branches of domestic-grown Chinese chestnut trees in order that the latter may be rated, according to tannin content, for seed propagation.

VEGETABLE-TANNED AND CHROME-RETANNED SOLE LEATHER

Experiments to obtain comparative data on tannage and wearing quality of vegetable-tanned and chrome-retanned sole leather showed that on an average the light to medium retanned chrome sole leather, even though thinner than the vegetable-tanned leather, wore from 60 to 80 per cent longer. The wear of chrome-tanned sole leather decreases as the amount of vegetable retanning is increased. In respects other than wear resistance, vegetable-tanned sole leather is superior. Chrome tanning is much faster than vegetable tanning. The natural supplies of vegetable tanning materials are gradually decreasing. These experiments point out the desirability of developing a leather combining the greater wear of chrome tannage with the good properties of vegetable tannage. The development of such a product is worthy of most serious and concerted efforts, since it would decrease our dependence on foreign sources of hides, conserve vegetable-tanning materials, give the people a product of lower production cost and greater serviceability, and reduce materially the slow turnover of the present process for vegetable-tanned, heavy leathers.

BOOKBINDING LEATHERS

Investigations on the deterioration of bookbinding and other leathers have been continued and show that a number of factors contribute to the decay of leather bindings, chief among which is the presence of harmful acids, either left in the leather from finishing processes or taken up from the atmosphere, which numerous investigations, abroad and in this country, have shown conclu-

sively is usually contaminated to a greater or lesser extent in the vicinity of large cities or manufacturing centers. Work is being done on the prevention of damage from contaminated atmosphere.

Formulas for making several preservative dressings and directions for applying them are contained in a leaflet entitled "Preservation of Leather Bookbindings" now in press.

During the year more than 80 bookbinding leathers have been examined and analyzed for the Government Printing Office. The results compared with those obtained several years ago on corresponding bid and award samples show a general improvement in quality, and it may reasonably be expected that bindings made with these leathers will prove to be more durable and economical.

PAPER AND FIBER BOARD

Plant fibers (including wood) are the principal raw material for the manufacture of paper and fiber board, the annual production of which in the United States amounts to about 12,000,000 tons, with a value of about \$1,000,000,000. With fibrous by-products amounting to millions of tons annually, agriculture is keenly interested in the paper and fiber-board industry as a possible purchaser of such by-products. The object of the work being done on paper and fiber-board investigations is to acquire and disseminate information on the possibility and practicability of utilizing agricultural by-products in making paper and board and on the chemical and physical properties needed in papers to be used for specific purposes.

BAGASSE AND CORNSTALKS

During recent years widespread interest has been shown in the utilization of cornstalks, bagasse, straw, and other agricultural by-products for making paper and fiber board. Economic considerations bearing on this subject have been given careful attention, and close contact has been maintained with experimental and industrial developments. There have been many calls for information on these subjects from officials in this department, from Members of Congress, and from the general public. A circular was prepared and distributed to correspondents seeking such information.

Paper and boards have long been made on a commercial scale from straws. Within recent years the production of insulating and building board from sugarcane bagasse and straw, as well as from wood, has become fully established, with the consequent development of a limited market for these by-products of the farm.

DETERIORATION OF PAPER

Some years ago the Secretary of Agriculture, anticipating the almost certain destruction within a comparatively short time of priceless legal and historical printed and written records, and realizing the necessity for having the most durable papers for keeping such records, directed the bureau to inaugurate work on the durability of paper and its suitability for various purposes, and to work out specifications that would insure more durable and more suitable papers for Government and commercial use. The paper used by the

Federal Government is purchased upon specifications prepared largely as a result of this research activity.

In the continuation of this work much has been done on the chemical, physical, and microscopical examination of papers of the more important kinds and of various ages, and special attention has been given to methods of analysis and examination and to the effect of sizing materials, inorganic acids, aluminum sulphate, and nature of stock on durability of paper. The bureau's work on the deterioration and suitability of paper is moving along lines originally outlined and will be expanded and vigorously pushed.

PAPER SPECIFICATIONS AND TESTS

The bureau continues to assist the Government and scientific societies in the preparation of specifications which will make possible the procurement of papers best suited for specific purposes. Samples of miscellaneous papers submitted by purchasing officers of this department have been tested and advice given regarding purchases.

Relative resistance to fading by light was determined on series of copies produced from originals made with three kinds of hectograph carbon paper and three kinds of hectograph typewriter ribbons.

Assistance was given to the postage stamp division of the Bureau of Engraving and Printing in determining the relative adhesive qualities of four experimental lots of gummed stamps.

FARM FABRICS

The purpose of this work is to devise and improve treatments for canvas, tobacco shade cloth, and other cotton fabrics used out-of-doors on farms and elsewhere, which will make them more serviceable and more durable through increased water repellency and resistance to destructive agents such as light, fire, acids, and mildew. The work has included collaboration with industrial firms in determining the cause of discoloration of blue awning stripes and the comparative mildew resistance of awning stripes produced with different dyes and pigments, in suggesting pigment compositions that would resist mildew, and in testing the mildew resistance of commercial preparations and treated fabrics; collaboration with the Post Office Department in determining the causes for rapid deterioration of mail bags; and collaboration with the War Department in an effort to determine the cause of corrosion of brass cartridge cases which come in contact with bandoleer fabric.

FIREPROOFING OF COTTON CANVAS

Active work on the permanent flame-proofing of cotton fabrics was inaugurated. The literature on the subject has been abstracted and previous work on the subject summarized in an accessible form as a foundation for the experimental work. Thus far the efforts to find a satisfactory flame-proofing agent have been confined to simple treatments except for the so-called permanent inorganic materials, involving insoluble salts which must be precipitated by suc-

cessive immersion in at least two different aqueous solutions. Mixtures of organic and inorganic treatments have not yet been tried. Certain of the treatments devised and tried have shown some promise since they render the canvas incombustible and have other desirable characteristics. One treatment, as a result of which cotton fabrics have shown good flame resistance in preliminary tests, gives exceptionally promising results. However, much more remains to be done.

NAVAL STORES

The annual production of turpentine and rosin, the principal materials in the class of pine-tree products known as naval stores, has a value of \$50,000,000 to \$60,000,000.

While naval stores are valuable and essential products of farm and forest, the practices and methods of production in many localities are such that operators frequently fail to make a profit. The purpose of the work under this project is to improve practices, processes, and equipment so as to prevent wastes, reduce costs of production, obtain products of better quality, and promote utilization. It is conservatively estimated that the work of the bureau in improving naval-stores practice is potentially worth a million dollars annually to producers.

TECHNOLOGICAL WORK

The naval-stores technologist visited 54 turpentine places and stills for the purpose of giving instructions in and demonstrations of improved stilling practices and information on various naval-stores problems, and has supervised the setting of eight fire stills in accordance with the improved design worked out by the bureau. The number of persons witnessing and profiting from this work was 392. Information on naval-stores problems was also given to 130 persons who called at the office in Savannah and to 124 persons at the State forestry fairs and at a general meeting of naval-stores men in Jacksonville, Fla. In addition, much information has been given through correspondence.

It has been found that fire stills erected under the bureau's supervision require less than the usual amount of fuel and that wherever still settings approximate the bureau's plans they work much better and more economically than the old-style construction and make better grades of rosin, as a rule. Stills erected under bureau supervision have become demonstration units for the surrounding country, numbers of operators calling to see the stills run during the operating season.

Steam stills previously erected in accordance with designs and specifications prepared by the bureau have continued to show satisfactory results in operation, with a saving of time and fuel.

GUM CLEANING

The large laboratory-scale work on gum cleaning has been completed with the production of gum containing but a trace of foreign matter and which yields rosin of great transparency and brilliancy, rosin that is as transparent as glass of the same color. The problem of filtering gum has apparently been solved, and steps have been

taken to prepare the plans and specifications, build full-size equipment, and conduct cooperative work therewith at one of the producers' plants in Florida before the close of the present season in order that this equipment, if found to work satisfactorily, may be available to producers during the season of 1931-32. It is estimated that if this equipment works as well commercially as it has worked on a large laboratory scale it will very materially increase the value of rosin to the producer, eliminate 75 per cent or more of the losses of rosin which now occur in dross, and that the rosin will be worth more to all the users because it is clean and uniform.

COMPOSITION OF TURPENTINE

Samples of gum spirits of turpentine and of steam-distilled wood turpentine have been fractionated and the relative proportions of alpha and beta pinene and tailings in gum turpentine have been determined on the fractions by the optical method of Darmon. Accumulation of such data on various American turpentines will be useful in evaluating turpentines for the manufacture of chemical products, as, for example, synthetic camphor.

TURPENTINE STORAGE

Laboratory experiments on the storage of turpentine in glass containers in contact with various materials having a reducing effect, a dehydrating effect, or a combined reducing and dehydrating effect have been continued.

After two and one-half years' storage the materials which have proved most effective in preventing deterioration of gum spirits of turpentine are lime (CaO) and magnesium in powdered form. The turpentine stored in contact with these materials was water white, had the sweet odor of fresh gum spirits, and showed no evidence of deterioration. Lime would be the most practical material to use from the standpoint of availability and cost. Bone char prevented the development of rancidity, but the turpentine acquired a yellowish color. A number of organic reducing compounds prevented rancidity but discolored the turpentine. This would not prevent their use in colored turpentine products like shoe polishes. An interesting observation made in connection with these experiments was that turpentine stored in contact with stannous chloride had a decided odor of limonene and terpineol. This matter is being investigated.

In collaboration with a commercial firm, physical and chemical constants were determined on four samples of turpentine to show the effects of storage. These were the last of a series of tests, at 6-month intervals, covering a period of three years. Only slight changes had taken place in these turpentines which had been stored under conditions recommended by the division and designed to prevent oxidation; that is, in full tanks kept free of water and separated from the outside air by liquid seals.

GLUING TURPENTINE BARRELS

The loss of turpentine through leakage has been estimated as more than \$60,000 annually. The bureau is at work to improve the present methods for coating the inside of turpentine barrels to

prevent leaking and absorption of turpentine by the wood or to devise practical new methods for the purpose.

It has been the custom to coat the inside of turpentine barrels with hot glue solution to prevent leaking and absorption. When proper care is exercised in the selection, preparation, and application of the glue, and when the turpentine is thoroughly cooled and free from water, the method is generally satisfactory. Observations in this field have shown that very often gluing is poorly done and that leakage results from the method of gluing and from the quantity used rather than from the quality of the glue or the way it is cooked. Efforts have been made to improve ordinary gluing practice and to devise methods which require less care in application. Laboratory experiments have indicated that exposure of freshly glued surfaces to formaldehyde vapor results in quicker setting, considerable water resistance, and flexibility. Following recommendations of the bureau, a number of producers are trying out the use of formalin in gluing barrels.

EFFECT OF CUPS ON GRADE OF ROSIN

Analyses of rosins made from gum collected in galvanized-iron cups, zinc cups, and aluminum cups showed that the rosin collected in galvanized-iron cups contained nearly three times as much iron as that collected in zinc or aluminum cups, and that the rosin was several grades darker.

COMPONENTS OF GUM

In collaboration with the United States Forest Service, 48 samples of crude turpentine gum or "dip" and 15 samples of "scrape" were analyzed for turpentine, rosin, and extraneous material, and the grade of rosin that could be made from each sample was determined. In these laboratory tests the lowest grade of rosin made from fourth-year gum was K from longleaf and WG from slash gum. From one exceptional slash gum (fourth year) M grade rosin was made. While it is not likely that the average producer will make these grades from similar gums, the results do indicate the possibility of making better grades of rosin when all precautions are taken.

USES OF NAVAL STORES

The quantity of turpentine and rosin used in this country amounts to about half of the total domestic production and has an annual value of \$25,000,000 to \$30,000,000 at primary markets. Rosin holds the important position of an essential raw material in the manufacture of many products, including paper size, soap, varnish, printing ink, and plastics. Turpentine, used in the manufacture of synthetic camphor and of ready-mixed paints and largely in the manufacture of varnishes, still finds its largest use as a safe and dependable thinner in the hands of the applying painters.

The bureau is working to promote the utilization of naval stores by studying their composition and properties, and determining how they may be used in new products and how they may be used to best advantage or improved for use in old products.

NAVAL-STORES HANDBOOK

Publication of the naval-stores handbook which is being prepared in cooperation with other interested bureaus of the department has been delayed by pressure of other work. Progress in its preparation is being made, and it is expected that it will be issued in 1931.

EXHIBITS

Additions have been made to the exhibit material on naval stores. These additions have been made to those exhibits made through the office of exhibits and also through the museum and to exhibits retained by the bureau itself. Such exhibits are found especially helpful in the bureau's technological work in the field and in informing producers and users about the methods and difficulties of production and the need for improving products.

STATISTICS

The compilation of statistics on the consumption of naval stores was undertaken in 1918 at the persistent request of producers and users of naval stores because the information can not be obtained as promptly or as reliably by any other agency. Comparison with statistics for former years allow estimates of future demands and thus are of service in planning production and use. Work has been started on statistics of industrial consumption during 1929 and stocks on hand at the close of the naval-stores season, March 31, 1930.

OIL, FAT, AND WAX INVESTIGATIONS

Fats and oils from new sources are being studied in the oil, fat, and wax laboratory, in order to discover their economic value. Much attention is also being paid to further investigations of the composition of commercial fats and oils. In addition to these studies, attention is being given to new research methods and to methods for testing the purity of fats and oils.

PALM OIL

Palm oil is used extensively in the United States by the soap makers and the tin-plate industry. With the improvement in the quality of the product from Sumatra, increasing quantities are becoming available for use, after refining, in the manufacture of oleomargarine, for which it is particularly well adapted.

In view of the fact that commercial palm oil is produced in various tropical countries from a number of different varieties of the African palm (*Elæis guineensis*) and because some varieties differ greatly from each other, it is important that this study should be extended to include the palm oils from the more important producing countries, especially as comparatively little is known regarding their composition. These results will be of value to the soap makers and oleomargarine manufacturers, as well as to those engaged in the cultivation of oil palms, if they indicate that the oil from certain varieties is noticeably superior to that from others.

During the last year the characteristics and composition of an authentic sample of Sumatra palm oil have been determined. The palm oil from the Belgian Congo, previously examined, contained considerably less linolic and more stearic acid than the sample from Sumatra.

CHIA-SEED OIL

Chia is a native of Mexico, where it is being cultivated in increasing quantities for its seed. There is the possibility of its future cultivation as an oil-seed crop in some of the Southern States. Chia-seed oil belongs to the drying class of oils and has been found suitable for use in the manufacture of various kinds of paints, enamels, and varnishes, as well as oilcloths and linoleums. The investigation of the expressed oil has been completed and the results have been published.

GRAPEFRUIT-SEED OIL

The characteristics and composition of the expressed oil have been determined, and, for the purposes of comparison, the characteristics of the oil obtained by solvent extraction also. The quantity of seed separated annually at the canning plants amounts to about 600 tons. It is expected that the quantity of seed obtained will be increased shortly, owing to the rapid expansion of this comparatively new industry. Experiments were made which showed that the oil could readily be converted into a light-colored medium-hard soap that possessed good lathering qualities. As a result of these studies it is believed that the crude oil could be sold to advantage to the soap makers.

PECAN OIL

The characteristics and composition of pecan oil have been determined. The oil studied was expressed from unsalable fine nut fragments. It had a very mild, agreeable taste and was found particularly suitable for use as a salad or a cooking oil. Upon saponification it gave a soap with excellent lathering qualities. The oil has good keeping qualities.

METHODS FOR THE ANALYSIS OF COTTONSEED

Throughout the year an extensive study has been made on known and suggested methods, as well as on the development of other methods in connection with the work of the interbureau committee on the sampling and analysis of cottonseed. It is of importance that cottonseed be graded by selected methods by which the actual quality of any lot of seed can be determined.

The work of the members of the committee in this bureau is confined to a study of the methods of analysis. Existing methods have been subjected to critical study, with the result that suitable procedures have been selected for the determination of moisture and nitrogen (protein). As no known method was entirely satisfactory for the determination of the oil, it became necessary to develop one adapted to this purpose. A modification of the present official method of the National Cottonseed Products Association was obtained that appears to give satisfactory results, but certain phases of the method require further study.

NUTRITIONAL INVESTIGATIONS

CHEMICAL INVESTIGATIONS ON PROTEINS

Cooperative work has been carried on with the Hygienic Laboratory of the United States Public Health Service in estimating the cystine content of a number of proteins by means of the Sullivan colorimetric method. Extensive investigations formerly conducted in this bureau on the nutritive value of the proteins of a number of beans and legumes, including the navy bean, Lima bean, adzuki bean, lentil, and cowpea, have shown that these proteins, in an otherwise adequate diet, will not support the growth of young animals unless the amino acid cystine is added to the diet. The percentages of cystine now found in the legume proteins by means of the more recent and distinctive colorimetric method are much lower than those formerly found and are entirely consistent with the results of the former feeding experiments. This is an interesting illustration of the fact that in some cases feeding experiments can be a more reliable way of detecting amino-acid deficiencies of proteins than chemical analyses.

Work has been continued on the proteins of sweetpotatoes, and the proteins of two varieties of sorghum—milo and feterita. Further work has been done on the study of glutelins.

Sweetpotatoes rank second in importance as a truck crop, and constitute one of the chief vegetable foods in the Southern States. The annual commercial production in the United States is approximately 85,000,000 bushels, with an approximate farm value of \$80,000,000. Compared with other root vegetables, sweetpotatoes rank high in protein, containing an average of about 2 per cent.

Some varieties contain more than 3.5 per cent. These proteins have been found to be good sources of some of the amino acids that are essential for the growth and satisfactory nutrition of animals and which are lacking or deficient in the proteins of certain seeds and cereals. For this reason sweetpotatoes should be a valuable supplement to correct the deficiencies of the proteins of corn, wheat, grains in general, and several of the legume seeds, such as the navy bean, Lima bean, cowpea, and lentil.

In 1925 approximately 4,500,000 acres of grain sorghum were planted in the southwestern part of the United States. In certain sections of the United States sorghum is preferred to corn by the farmers because it is better suited to local climatic conditions. The number of acres devoted to the production of sorghum is steadily increasing from year to year. Of the three horticultural varieties of sorghum, kafir and milo covered three-fourths of the total number of acres, whereas only one-fifteenth was used for feterita.

Investigations in this bureau have recently shown that the chief protein present in these sorghum varieties is an alcohol-soluble protein (prolamin). Kafir prolamin had been previously prepared and analyzed. From a nutritional standpoint, it was very important to determine whether or not these proteins lacked any of the nutritionally essential amino acids, particularly in view of the fact that it was known that unless grain sorghum was fortified by other feed proteins the animals showed nutritional disturbances. It was found that milo lacks tryptophane and that feterita contains only a small

amount. The distribution of the other amino acids was also determined.

Investigation on the effect of alkali on proteins has been continued. Considerable evidence is available showing that many proteins which have been isolated from natural food products do not represent the native proteins as they existed in the original material, but have undergone changes during the process of their isolation. This is particularly true in cases where the proteins have been exposed to the action of even dilute alkali.

It is a matter of great importance to know whether the proteins are changed in their chemical or physical properties by the use of alkali in processing some of our cereal foods. Since glutelins represent one of the chief proteins in cereals, efforts have been concentrated on determining the effect of alkali on this class of proteins. As a criterion for studying the changes, the optical behavior of the cleavage products has been used. It was found that the changes which take place are proportionate to the strength of the alkali used and to the temperature to which the alkaline protein solution is subjected; also to the length of time the alkali is in contact with the protein. As a result of this investigation, which is still of a preliminary nature, it has been found that alkali does not racemize proteins at body temperature, since optically inactive cleavage products can not be obtained except when the hydrolysis is carried to the amino-acid stage. It is intended to continue this work and to determine whether or not it is true that the so-called racemized proteins are digested by proteolytic enzymes.

BIOLOGICAL INVESTIGATIONS ON PROTEINS AND VITAMINS

Additional space and equipment have been made available during the year for the nutrition laboratory. This laboratory is now very well provided with space, facilities, and equipment for carrying on nutritional work with small animals, including automatic temperature control, the latest type of cage racks, a room and apparatus for microphotographic studies of bones and tissues, a specially devised apparatus for preparing large quantities of vitamin-free casein for feeding experiments, and equipment for work with ultra-violet light.

A cooperative arrangement between this bureau and the Bureau of Fisheries has made possible the undertaking of nutritional studies on fishery products and by-products. The extensive and rapidly increasing use of these products, in the feeding of farm animals, particularly the use of fish meals and fish oils for supplying vitamins A and D, gives them a place of great importance in the field of agriculture. As a result of this cooperation between the two bureaus results have already been accomplished, at a minimum expense to the Government, which, it is believed, will be of great benefit to both the agricultural and fishery industries of the United States. More than half the cod-liver oil used for domestic consumption is imported, most of which is used in animal feeding.

A study of vitamins A and D in several of the most important fish oils has been completed. The total production of fish oils, other than fish-liver oils, in this country is more than 10,000,000 gallons. The production of the most important oils ranges from approximately 4,000,000 gallons for pilchard to 25,000 gallons for tuna. The quan-

tity of fish-body oils can be greatly increased and the quality improved. At present these oils are used principally in the soap industry and as drying oils in the paint industry, and to some extent for sizing leather and tempering steel. The suprisingly high potency of vitamins A and D found in some of these oils, together with the enormous potential supply of the oils, gives them a marked significance as sources of these vitamins.

Fish oils representative of the quality of oils available in commerce have been tested for vitamins A and D. The oils used were menhaden, pilchard, Maine herring, Alaska herring, salmon, and tuna. Of these oils only salmon oil contained enough vitamin A to make its use practical in animal feeding. This oil was found to have nearly one-half as much vitamin A as an excellent grade of medicinal cod-liver oil and is within the range of the poorer cod-liver oils in vitamin A potency. Assigning to the vitamin D value of cod-liver oil the arbitrary figure of 100, the oils studied would have the following vitamin D values: Tuna, 100; pilchard, 100; menhaden, 75; salmon, 50; Alaska herring, 30; and Maine herring, 20. Since these oils sell for approximately one-third of the price of cod-liver oil, salmon oil is a cheaper source of vitamins A and D than cod-liver oil. Bearing in mind that none of the oils used were prepared with the idea of preserving the vitamins and that the potential supply of salmon oil alone is three times as great as our present supply of cod-liver oil, these findings take on added significance.

Work has been continued on the effect of commercial processes and practices on the nutritive value of foodstuffs. During recent years a large number of commercial processes used in the preparation of foods have been developed which may have a pronounced effect upon the food value of the original material. Definite information in many cases regarding the effect of these processes on vitamins, proteins, and other food factors is not available. During the year three problems in this connection have arisen which are of such immediate practical importance that it was deemed advisable to cooperate in their study at the expense of suspending certain fundamental researches already in operation. It was shown that the practice of treating unripe fruits and vegetables with ethylene gas, which induces a coloration of the treated products to simulate those naturally ripened, produces fruit of inferior vitamin value when applied to tomatoes. Orange juice and tomato juice are the principal sources of vitamin C for infants. The juice of tomatoes ripened on the vine is a better source of vitamins A, B, and C than the juice of ethylene-treated or green fruit. The vitamin A, B, and C content of ethylene-treated tomatoes was not different from that of similar untreated fruit in early or late stages of maturity. The vitamin C content of tomatoes increases as the fruit matures and reaches a maximum in the fully matured, naturally ripened fruit. There was no evidence of any deleterious effect on the vitamins present in tomatoes ripened by ethylene treatment.

Drastic methods have been instituted to eradicate the Mediterranean fruit fly from Florida. To combat the adult fly, trees are sprayed with arsenical sprays to which has been added a certain amount of molasses to serve as a bait. Although this procedure has been found to be very effective in reducing the number of flies, the

spraying produces marked changes in the character of oranges from sprayed trees. There is a marked decrease in organic acids and a change in the type of sugars of the mature fruit. To prevent the spread of the fly into noninfested areas through larvæ, oranges are subjected to a prolonged heat treatment. Since oranges are an important source of vitamin C, particularly for infants, the effect of methods instituted to combat the fruit fly on the vitamin content of the fruit is of importance. Studies carried on during the year have shown that the practice of spraying orange trees with arsenates decreases materially the vitamin C content of the oranges produced.

There is also under way a study of the effect of sulphur dioxide treatment on the vitamin C content of apricots. In the commercial drying of fruits the practice of sulphuring has been well established.

A publication which appeared during the past year demonstrated that although vitamin C is destroyed completely when apricots are dried without sulphur dioxide treatment, the vitamin can be preserved under certain conditions of drying in the presence of sulphur dioxide. Sulphuring has been carried on largely for the purpose of preserving the color of the fruit, and in the past attempts have been made to discourage the practice because of the possible injurious effects of sulphur to the human organism. If sulphuring improves the nutritive value of the fruit under commercial conditions, its disadvantages may be offset.

Apricots that were dried during the summer of 1929 at the Los Angeles fruit and vegetable chemistry laboratory of the food research division have been received for vitamin studies. Feeding tests have been started.

Cooperative work also has been carried on with the National Cottonseed Products Association through a fellowship established in this bureau for the study of problems associated with cottonseed cake meal feeding. These studies are largely a continuation of work done the previous year. Several important results of a fundamental nature have been accomplished which will form the foundations for a more thorough study of related problems. The importance of cottonseed cake meal as feed is realized when it is considered that during the years 1926-27 and 1927-28 the total consumption amounted to nearly 2,000,000 tons and 1,500,000 tons, respectively. A considerable quantity, in addition, is used as fertilizer. Furthermore, its high content of protein and of vitamins B and G, together with the fact that it is a good source of inorganic salts, make it very desirable to study further its nutritive properties and more satisfactory methods for its commercial production as a feed.

High-grade cottonseed meal has been shown to contain an abundance of vitamins B and G. The particular meal studied contains approximately one-half as much of these vitamins as dried yeast. In view of the fact that yeast is used as a specific for pellagra because of its vitamin G content it seems possible that properly prepared cottonseed cake meal may become an important article of human food.

A preliminary study of the nutritive value of the proteins of cottonseed meal has shown one meal to contain excellent proteins. There is reason to believe that the quality of the protein of different meals may vary.

Studies of the vitamin content of sugarcane juice and some commercial products made from it show that sugarcane juice contains a small amount of vitamin A and little, if any, vitamin D; that sugarcane juice is a poor source of the antineuritic vitamin, and the juice from the upper portions of cane stalks is richer in this vitamin than juice from the lower portions. Juice obtained from bagasse by using high pressure is richer in the antineuritic vitamin than ordinary cane juice. Cane sirup, Louisiana, and Porto Rico blackstrap molasses, and cane cream, products made from sugarcane juice, were found devoid of demonstrable quantities of vitamin B.

There were no demonstrable amounts of vitamins A or D in the oil obtained from avocados. A dry, fat-free meal prepared from the pulp was tested for vitamins B and G. The meal was prepared by drying the pulp of the fruit in a current of air, and the oil was then expressed by pressure. The press cake was extracted with petroleum ether and again dried. This meal is excellent material as a source of both vitamins B and G, being about half as potent as an excellent quality of dried yeast.

During the past year the bureau has reported the results of 32 vitamin assays to the drug control laboratory. Fourteen vitamin-A, 16 vitamin-D, and 2 vitamin-B determinations were made. This work is carried out under the cooperative arrangement whereby the division conducts the assays on commercial products alleged to contain vitamins, that come under the surveillance of the organization charged with the enforcement of the Federal food and drugs act.

During the past year the bureau has improved its technic in vitamin A assay. In most laboratories the period of depletion of stored vitamin A ranges from four to six weeks or even longer. Attempts to reduce the depletion period usually result in producing inferior test animals. By applying the method of controlling vitamin A storage described in a publication from this bureau, excellent animals have been grown which can be depleted of their vitamin A storage and are suitable for curative tests three weeks from the time they are weaned.

COLOR AND FARM-WASTE INVESTIGATIONS

DYE INTERMEDIATES

Vat dyes are chiefly used in dyeing cotton goods and artificial silks. The consumption of such dyes has increased to more than 9,000,000 pounds in 1929 as compared with 6,500,000 pounds in 1928. The work of this division deals with the production of new vat-dye intermediates. Such intermediates present a means of meeting the competition of foreign vat-dye specialties, which amounted to 2,500,000 pounds in 1929 in spite of the increase in domestic production. Several new intermediates have been synthesized during the past year and are now receiving the consideration of the dye industry.

Naphthanthraquinone is produced by the combination of phthalic anhydride and naphthalene in the presence of aluminum chloride. At the time that last year's report was filed this work was still under way. Since then the subproject has been completed, the results have been published, and the process is now before the indus-

tries for their consideration. The bureau has succeeded in solving the main difficulty which was under consideration at the time of the last report, namely, the closing of the naphthanthraquinone ring in the preparation of alpha-benzoyl-benzoic acid. Yields have been obtained on this part of the process in excess of 90 per cent, with an over-all yield of nearly 90 per cent on the phthalic anhydride used.

Work on the problem of preparing phenylanthraquinone and derivatives from 2-chloro and 4-chloro-diphenyl has resulted in the conclusion that they are so closely related that it is best to make a report on them as a unit. The reason for this is chiefly that there is little difficulty in preparing the phenyl-benzoyl-benzoic acids from either diphenyl or chloro-diphenyl, and it is practical to make the substituted phenylanthraquinones, whereas a great deal of trouble has been experienced in closing the ring to form the unsubstituted phenylanthraquinone. Twelve new compounds have been synthesized and their physical constants established. The chemistry of the keto acids has been investigated, and information of value has been obtained both as to the structure of these materials and as to the influence of substituents in the phenyl nucleus on the ring closure.

BIOLOGICAL APPLICATIONS OF DYES

During the past year several new stains, which will be of great value have been synthesized. There has been extensive cooperation with the Garvan Cancer Research under Doctor Bloodgood, of Johns Hopkins University.

This project is concerned with the biological application of dyes, both for the advancement of pure science and for the utilization of science in numerous matters of vital practical importance. In the past the work has been carried on in close collaboration with the Army medical authorities and with the Commission on Standardization of Biological Stains. At a meeting of the commission held on April 15, 1930, representatives of all three agencies expressed satisfaction with the progress of the year's work, and their appreciation of the bureau's assistance in the prosecution of their activities.

In the synthesis of biological stains and dyes of therapeutic or antiseptic value, the most extensive research of the year has been concerned with the synthesis and study of a comprehensive series of magentas. It is hoped that this investigation will eventually make possible the explanation of anomalies which are met with in various staining applications of these dyes, and that it may lead to practical improvement in staining in this field which will parallel the advancement of staining in other fields following other investigations of this division. A variety of aluminum salts and lakes of dyes and an extensive series of compound dyes were prepared for the Garvan Cancer Research, of which a number are proving of considerable practical interest and importance.

MISCELLANEOUS INVESTIGATIONS

The work of the year was of a very miscellaneous nature. The solubilities and light absorptions of a number of stains were determined for the Garvan Cancer Research. A spectrophotometric

study was made of a proposed colorimetric method for the differentiation of natural and artificial oil of sassafras for the Food and Drug Administration, and numerous samples of mercurochrome and substitutes were examined for the same organization. The spectrophotometric analysis of 60 solutions of plant pigments was carried out for the Bureau of Plant Industry in connection with their investigation of virus activities in mosaic diseases.

A novel and comprehensive scheme was developed for the identification of stains by means of convenient spectrophotometric technic. Satisfactory and convenient spectrophotometric methods were developed for the analysis of neutral red, pyronine G, and pyronine B, three important stains which can not be evaluated by reduction methods, and which can not be analyzed by other chemical methods owing to the nature of the impurities which market supplies of the dyes contain.

FARM-WASTE INVESTIGATIONS

The work on bagasse cellulose has resulted in the production of a cellulose with an alpha content of 90 per cent or more, and an alkali-soluble content of 8 to 11 per cent. The pulp is produced in yields of 32 per cent on the air-dried bagasse and is more than equivalent to the Brown Co.'s alpha cellulose or the Riordan sulphite pulp, both of which are used in rayon manufacture. It would seem that the use of this cellulose would be conditioned very largely by the price at which bagasse could be purchased.

The work on lignin is of special importance because of the enormous annual production of this material, which has been estimated as 40,000,000 tons. There are two main sources of loss. One is the annual farm wastes, such as cornstalks, corncobs, straw, etc., and the other is the waste liquor from the various paper mills. The work during 1930 has been more predominantly chemical than that during 1929.

The work on destructive distillation of lignin has taken the form of a more careful examination of the fractions obtained in the destructive distillation. The greater active portion of the phenolic fraction is not volatile with steam, and a great deal of the work has been done to find out, if possible, the nature of these phenols. Up to the present time they have been divided into fractions by distillation under reduced pressure, and it has been found that by far the greatest portion of the material came over at or below 140° C. Further than this none of the materials has been identified.

Lignin has been found to give resinous condensation products with the following compounds: Furfural, o- and p-toluidine, p-nitroaniline, m-toluylene diamine, alpha and beta naphthylamine, tolidine, cyamidine, aniline, o-nitroaniline, and dimethylaniline. A table has been prepared summarizing the optimum temperature, time of heating, the ratio of lignin to the second component, and the properties of the rosin. Further investigation on this work will await the opinion of industry on its possibilities. Most of the rosins are of the fusible and soluble type, and may be used as varnish rosins.

Investigation of the formation of lignin in growing plants was undertaken in cooperation with the bureau's laboratory of crop chemistry to determine whether lignin is a factor in bringing about

lodging or the falling or bending over of plants during a wind or rain storm. It has been found that crops which have been heavily treated with nitrogen are apparently more susceptible to lodging than others of the same kind. Two plots of wheat were selected for this work; one was untreated and one heavily treated with nitrogen. Lodging finally resulted in the second plot. Periodical samples indicated that the lodged plants invariably and consistently contained a greater percentage of lignin. It appears, then, that the excess of nitrogen in some way stimulates the plant to produce a greater percentage of lignin which in turn increases the tendency to lodge.

Experiments on the modification and degradation of lignin have demonstrated that various oxidizing agents either have no effect on the lignin and methylated lignin or break it down so far that only the simpler organic acids, such as oxalic, acetic, and succinic, are produced. Such products give no information whatever about the basic structure of the lignin molecule, which is the chief objective of this subproject.

Certain sulphonation experiments have indicated the following: (1) Free lignin in contradistinction to lignin as it is found in the plant is comparatively resistant to the action of the mixture of SO_2 and bisulphite (the active delignifying agent in the so-called sulphite process). (2) The insoluble residue is not merely lignin which had resisted the action of SO_2 and bisulphite, but is a sulphur-containing compound (insoluble in lignin sulphonic acids). The last two facts are of special interest in connection with the sulphite process for paper pulp. Work on this is being continued, using lignin prepared by various methods.

Experiments were also conducted on the distillation of lignin with zinc dust in an atmosphere of CO_2 . A yield of oil amounting to 19 per cent of the weight of lignin used in the experiment was obtained. This oil was steam distilled and 28 per cent was volatile with steam. This fraction, as well as the steam-nonvolatile fraction, was separated into phenolic and into neutral portions. Both fractions were found to be predominantly phenolic in character. In the steam-volatile fraction the phenols amounted to about 60 per cent of the oil, and in the steam-nonvolatile fraction to 80 per cent. The only phenol definitely identified is guaiacol. The steam-nonvolatile phenols were fractionally distilled under reduced pressure, and judging by the boiling-point range it was apparently a very complex mixture.

A considerable quantity of phenol-furfural rosin was made for the purpose of testing the possibility of using cornstalk flour as a filler in place of the more commonly used wood flour. In cooperation with companies at North Tonawanda and Lockport, N. Y., a number of articles which were very satisfactory in quality and appearance were molded from this prepared material.

Since the work on phthalic anhydride was started a great deal of valuable information on the subject of the catalytic atmospheric oxidations and catalytic oxidations of other kinds has accumulated in this division. It is thought, therefore, that any project which will utilize this information is of great importance in the work here. After some consideration, p-cymene, a well-known paper-mill waste, was chosen as a suitable material for a study along these lines.

Catalytic vapor phase oxidation of p-cymene.—A large number of runs have been made on p-cymene, using a variety of catalysts and including changes in various other conditions of operation. The best results have produced about 9.5 per cent of formic and 17½ per cent of p-toluic acids.

INDUSTRIAL FERMENTATIONS

During the year the semiplant scale process for the production of gluconic acid has been completed and the results published. Very largely as a result of this bureau's activities, calcium gluconate is receiving a great deal of attention as a physiological source of calcium.

The development of fermentation processes for the production of chemical products has been a leading feature of chemical development during the last 10 years. During the past year new companies have been formed for the manufacture of industrial solvents, and a number of visits have been made to this bureau for the purpose of obtaining advice and suggestions on the installation of plants for the manufacture of citric acid by fermentation. Considerable interest has also been manifested in the development by the bureau of a method of production of gluconic acid on a semiplant scale.

Prior to the work of the bureau there was nothing obtainable in the literature on the subject of the application of fermentation to industrial problems of this type, and it is apparent that the work that has been done and reported by this bureau will serve as a model for future investigations, whether made in this bureau or elsewhere.

An industrial process for the manufacture of gluconic acid, using a different organism but similar in other respects to the work of this bureau, is now operating. Before this process was announced commercially this bureau had, however, distributed between 100 and 200 pounds of calcium gluconate for experimental purposes in the country at large. Research based on this material will undoubtedly be of great value in the future.

Up to the present time a survey of the action of about 50 molds on solutions of xylose has been studied without any marked results. Apparently many of these organisms possess the property of utilizing xylose for their growth but do not produce metabolic products on a sensible scale.

INSECTICIDE INVESTIGATIONS

INSECTICIDAL PLANTS

Through the cooperation of the State Department, samples of plants reputed to have insecticidal action have been obtained from tropical countries. These have been examined and new compounds of insecticidal value have been isolated. "Cube" root from Peru has been chemically examined and found to contain about 7 per cent rotenone, the chief insecticidal constituent of Derris root. Timbo from Brazil has also been found to yield rotenone. Interest in rotenone has greatly increased as the result of the bureau's activities, and it is believed that within the coming year many proprietary insecticides manufactured within the United States will contain rotenone as the essential insecticidal constituent. Much progress has been made

in the study of the structure of the rotenone molecule, nine papers on this subject having been submitted for publication.

SYNTHETIC INSECTICIDES

Work on the synthesis of neonicotine has been continued. One of the large coal-tar manufacturers is now marketing an insecticidal mixture which contains a small proportion of neonicotine.

SPRAY RESIDUES

It has been found that a portion of the hydrochloric acid in the usual acid wash may be advantageously substituted by sodium chloride. This improved wash, which is not only cheaper than the one formerly used but is less injurious to the fruit and to the washing machinery, is now being commercially used in the Northwest.

ANALYTICAL INVESTIGATIONS

Methods for the determination of arsenical spray residue have been studied and their limitations determined. Statistical studies have been made to determine the number of apples required to constitute an adequate sample. A new method that has been studied for the determination of small amounts of arsenic promises to be superior to the Gutzeit method.

FLUORINE INSECTICIDES

New fluorine insecticides have been prepared and distributed to entomologists for testing against the European corn borer, Mexican bean beetle, codling moth, and other pests. One of these, potassium hexafluoroaluminate, has been prepared on a large scale by a leading insecticide manufacturer and extensive tests with it have been made in the field. Six applications for United States Public Service patents covering methods of manufacturing these fluorine insecticides have been filed.

FUMIGANTS

Ethylene oxide, which was developed in cooperation with the Bureau of Entomology in 1927-28, has grown rapidly in public favor. More than 3,000,000 bushels of wheat have been successfully fumigated with a mixture of ethylene oxide with carbon dioxide. This mixture has also been used commercially for fumigating dried and other foodstuffs.

ARSENICAL INSECTICIDES

A survey has been made of all brands of calcium and lead arsenate on the market. These two compounds are the most important commercial insecticides, about 30,000,000 pounds of each being used annually. This study of calcium arsenate will lead to the formulation of specifications defining a calcium arsenate suitable for the control of the Mexican bean beetle. Many of the present brands of calcium arsenate severely burn bean foliage when used for the control of this insect.

DUST-EXPLOSION INVESTIGATIONS

INERT GAS

In small grinding plants where inert gas is used for fire and explosion prevention, the obtaining of a sufficient quantity of suitable gas is not ordinarily a serious problem. In large plants, however, where a number of high-speed grinders of large capacity are used, the source of inert gas becomes a question of importance. Attention has therefore been directed toward the development of methods of obtaining flue gas from near-by boiler plants. In one of these installations it has been found necessary to install gas-washing or conditioning equipment because of the high sulphur content of the coal and the consequent need for removing SO_2 from the gas.

A special study of gas washers and conditioning equipment was made during the year and a complete test made of the equipment installed at one of the large feed-grinding plants. The results of these tests are being coordinated with the results obtained in the small-scale experimental equipment at the Arlington farm.

Experiments are under way at another plant using a large quantity of flue gas to determine the practicability of maintaining a temperature above the dew point of the gas to prevent precipitation of the SO_2 and moisture. In this way it may be possible in certain instances to eliminate any washing equipment.

INDUSTRIAL-PLANT STUDIES

In addition to the investigation of dust explosions which have occurred during the past year, studies were made in a number of industrial plants to observe unusual operating conditions or to obtain information of value in planning further research work on dust-explosion prevention. Visits for the purpose of observation of new methods and installations, testing conditions for dust-explosion hazards, and for making recommendations as to prevention of explosions were made to a large flour mill, two sugar refineries, a plant producing powdered-food products, an oil plant, a sulphur-grinding plant, a woodworking plant, a corn-sirup refinery, and several other industrial establishments.

LABORATORY RESEARCH

During the past year considerable data relating to the mechanism of dust-cloud explosions have been obtained. Most of the work was done with aluminum dust. These data show that not only does the maximum pressure increase with concentration, but the rate-of-pressure increase also increases with concentration, giving a doubly dangerous explosion. This indicates that considerable experimental work will be necessary to determine the practical possibility of explosion-venting devices. Tests were made for the determination of flame speed in dust clouds of constant volume. A study was made of the efficiency of a gas scrubber for the removal of SO_2 from flue gas. Thirty-four samples of dust sent in by various firms were tested for explosibility, and reports were prepared giving information concerning methods for reducing the explosion hazard.

DUST-EXPLOSION HAZARDS COMMITTEE

The very close cooperation that the bureau enjoys in this dust-explosion-prevention work with the industries, insurance organizations, underwriting agencies, State commissions, and safety organizations makes possible very prompt application of the control and preventive methods developed by the bureau engineers. One of the most prominent contacts is through the work of the dust-explosion hazards committee of the National Fire Protection Association which includes representatives from the following organizations: Corn Products Refining Co., American Spice Trade Association, Allen & Billmyre Co., Mutual Fire Prevention Bureau, Grain Elevator Construction Engineers, International Machinists Organization, National Bureau of Casualty and Surety Indemnity, Terminal Elevator Grain Merchants' Association, Railway Fire Protection Association, Westinghouse Electric & Manufacturing Co., National Board of Fire Underwriters, Underwriters Laboratories, Spencer-Turbine Co., United States Bureau of Mines, National Electric Light Association, International Association of Industrial Accident Boards and Commissions, Association of Governmental Labor Officials of the United States and Canada, and Associated Factory Mutual Insurance Companies. This committee under the leadership of the chemical engineering division of the bureau is preparing safety regulations for the industries in which dust explosions have been experienced.

Meetings of the committee were held in New York October 14, 1929, and in Chicago March 11, 1930. At these meetings special consideration was given to the preparation of safety codes for wood-flour manufacturing plants, spice-grinding plants, and the use of inert gas for fire and explosion prevention. The bureau cooperated during the year with the national fire waste council of the Chamber of Commerce of the United States. Meetings were held in Washington in October, 1929, and in March, 1930. The cooperation with this council affords an additional opportunity of translating into actual practice the results of the bureau's research through the fire-prevention committees of the local chambers of commerce throughout the country.

FARM-FIRE INVESTIGATIONS

SPONTANEOUS IGNITION OF HAY

Fires caused by spontaneous ignition are responsible for enormous annual losses. It has been estimated that spontaneous ignition of hay and other agricultural products results in an annual fire loss on farms of at least \$20,000,000, or one-fifth of the total yearly farm fire loss of \$100,000,000. Closely related to fire losses is the damage to agricultural and industrial products when spontaneous heating occurs which is arrested short of the stage of ignition. There is no basis on which to make any estimate of the aggregate losses resulting from such spoilage, but it is obvious that the total is enormous. During the year experimental work was carried on in a specially constructed barn on the Animal Husbandry Experiment Farm at Beltsville, Md. In the first experiment about 10 tons of incompletely cured alfalfa with a moisture content averaging 36 per cent was tightly packed in

the mow. Provision was made for the taking of gas samples when desired and samples of heated hay at the conclusion of the experiment. Every precaution was taken to avoid interference with the natural course of heating. Rather rapid heating occurred at first and comparatively high temperatures prevailed for a considerable time (highest temperature reached was 72° C.) but the heating stopped far short of those temperatures which were to be expected for actual ignition.

In the second experiment about 12 tons of baled alfalfa was placed in the barn. The bales were broken and water was sprinkled over several layers of the hay. About a week later a maximum temperature of 77° C. was reached in one section of the mow, after which the hay cooled rapidly.

Analyses of the hay and gas samples collected for laboratory study yielded interesting information. The relation between the carbon-dioxide content and the oxygen content in some of the gas samples indicates not only bacterial but also chemical action, this observation being a confirmation of certain experimental work of Haldane and MacGill. No evidence of easily inflammable gases was found. Further experiments with a much larger quantity of hay are needed, as the smaller stack gave too much opportunity for loss of generated heat.

CONFERENCE ON SPONTANEOUS HEATING AND IGNITION

A complete report of the conference on spontaneous heating and ignition, which was held in Washington, November 14 and 15, 1929, incorporating the several papers presented with ensuing discussion, has been prepared for publication and will be a valuable contribution to the literature on this subject. The final action of the conference was the adoption of a motion authorizing the executive of the National Fire Protection Association to organize a committee on spontaneous heating and ignition to continue the work initiated by the conference, to correlate research activities on the subject, and to serve as a clearing house for future work in this field.

EXHIBITS AND PUBLIC INFORMATION

To display the results of research in the bureau, exhibits were prepared on fertilizers and farm-waste materials, and the booth exhibits on soil erosion, naval stores, and dust explosions were improved. A model steam-still setting was built. The bureau participated in exhibitions at the Chemical Industries Exposition at New York; the National Fire Protection Association at Memphis, Tenn.; the Cambria County Industrial Exposition at Ebensburg, Pa.; the Illinois State Fair; the Greater Peoria Exposition, at Peoria, Ill.; the Alabama State Fair; the North Carolina State Fair; the conference on spontaneous heating and ignition at Washington, D. C.; the International Livestock Show; and the naval stores meeting at Jacksonville, Fla.

ENGINEERING DESIGN AND DEVELOPMENT

Engineering assistance is rendered to various divisions in the bureau in the design, installation, and operation of mechanical equipment for the commercial application of scientific discoveries for the utilization of agricultural resources, and to conduct engineer-

ing research on production costs, market values, and industrial development of chemical engineering processes using agricultural products as raw material.

During the past year all of the work on engineering design and development service has been conducted in cooperation with the industrial farm products division. Plans were prepared on the design of fire-still turpentine plants of 1-still and 2-still sizes. Observations were continued on the operation of the improved steam still designed and recommended by the department. The superheater which was designed by the department in connection with the steam-still installation has continued to give excellent service wherever installed. The work on gum cleaning has progressed beyond the preliminary stage. The theoretical principles involved in the process developed by the bureau have been tested.

Considerable work was performed on the development from cornstalks of a flour that would meet the requirements of the manufacturers of linoleum, dynamite, and artificial resins. In experiments with plastics using cornstalk flour as a filler, products having the same physical properties as those using wood flour as a filler were obtained. Experiments were conducted in producing a hard panel board from cornstalk flour and in obtaining a satisfactory surface for this board. Studies both of a large-scale and laboratory nature were made on the grinding and milling separations of cornstalk flour.

SOIL INVESTIGATIONS

THE SOIL SURVEY

The practical aspect of the work of the soil survey is expressed mainly in the number of square miles covered by the field parties each year. During the fiscal year 1930, 24,561 square miles, or 15,719,040 acres, of land have been covered and the soils mapped in detail. These maps show the different kinds of soils as determined by definitions, the definitions of the soils being given in terms of those characteristics which determine their natural productivity and their natural adaptability to crops. The maps show with great accuracy the acreage of each kind of soil, and the reports accompanying the maps supply the information for arranging all the soils in the order of their natural productivity, and for determining to what crops the natural characteristics of the soils of all degrees of productivity are best suited.

This information is of very great value to the agricultural industry of the United States whatever may be the status of that industry at any particular time. At the present time and for the immediate future, it has peculiar value because of the readjustment which is taking place in agriculture, as this is the information upon which the future inevitable land classification must be based. No land classification based on the natural productive capacity and the natural adaptability to crops of the soils is possible without the facts supplied by the soil survey. If this information were not supplied by the Federal survey, it would have to be supplied by each locality. The possible measure of its value, therefore, would consist of an estimate of what it would cost each community to determine the character of

its soils on its own initiative. We have no accurate information on the basis of which this cost can be determined.

An additional value of the soil survey which is probably as great, although it can not be expressed in dollars as can the practical value, consists in its scientific results. The soil survey is an institution for engaging in research in the field. The soil is studied in its natural habitat, not only on the basis of the characteristics of the soil itself but in relation to the environment in which it has developed.

In addition to the work of soil mapping and the research work that is carried on in the field, the results of which are expressed in the soil map and the report, investigations are being carried out on a number of collateral lines by the soil survey staff. These research projects consist of the work on soil erosion, peat and muck investigations, routine work in the determination of the reaction of soil types established by the soil survey, the preparation of a series of typical soil samples for educational purposes, investigations in the field for the Bureau of Reclamation, the Indian Service, the War Department in its flood-control work in the lower Mississippi Valley, the Treasury Department in the location of desirable sites for farms in connection with the establishment of institutions for the treatment of narcotic addicts, the Bureau of Public Roads in determining the influence of the character of the subgrade on the permanence of highway pavements, the Bureau of Standards in determining the influence of soil characteristics on the corrosion of iron pipes, the Bureau of Plant Industry in studying the causes of alfalfa failure in the Mississippi alluvial lands, and for the Department of State in the study of the influence of smelter fumes on crop plants in the northeastern part of the State of Washington. Most of these lines of work, in addition to their fundamental aspects, also include studies in the fundamental characteristics of soils. The results of these studies furnish scientific information determined for the first time, and therefore new to the field of soil science.

Tables 1 and 2 summarize the field work of the soil survey for the past year, to which is added a recapitulation of the areas surveyed since the inauguration of the work.

TABLE 1.—*Individual areas surveyed and mapped during the fiscal year ended June 30, 1930*

State	Area	Area surveyed	
		Square miles	Acres
Alabama.....	Dallas County.....	203	129, 920
	Mobile County.....	¹ 530	339, 200
	Perry County.....	¹ 270	172, 800
Arizona.....	Nogales area.....	98	62, 720
California.....	Capistrano area.....	¹ 342	218, 880
	El Cajon area.....	437	279, 680
	Suisun area.....	336	215, 040
Colorado.....	Greeley area.....	¹ 215	137, 600
	Longmont area.....	246	157, 440
Georgia.....	Hart County.....	¹ 97	62, 080
	Jefferson County.....	¹ 426	272, 640
	McDuffie County.....	241	154, 240
Idaho.....	Benewah County.....	361	231, 040
	Gooding area.....	¹ 116	74, 240

¹ These figures do not include portions of these areas surveyed in preceding years.

TABLE 1.—*Individual areas surveyed and mapped during the fiscal year ended June 30, 1930—Continued*

State	Area	Area surveyed	
		Square miles	Acres
Indiana.....	Jennings County.....	350	224, 000
	Pike County.....	¹ 273	174, 720
	Washington County.....	61	39, 040
Iowa.....	Calhoun County.....	¹ 486	311, 040
	Hancock County.....	406	259, 840
	Poweshiek County.....	¹ 137	87, 680
	Washington County.....	490	313, 600
Kansas.....	Marion County.....	¹ 440	281, 600
	Neosho County.....	¹ 529	338, 560
Kentucky.....	Mercer County.....	126	80, 640
Louisiana.....	Livingston Parish.....	188	120, 320
Maryland.....	Caroline County.....	¹ 155	99, 200
	Kent County.....	55	35, 200
	Talbot County.....	268	171, 520
Massachusetts.....	Franklin County.....	¹ 627	401, 280
Michigan.....	Alger County.....	¹ 185	118, 400
	Eaton County.....	¹ 274	175, 360
	Iron County.....	¹ 280	179, 200
	Luce County.....	¹ 805	515, 200
	Montmorency County.....	175	112, 000
	St. Clair County.....	¹ 132	84, 480
Minnesota.....	Hennepin County.....	¹ 81	51, 840
	Houston County.....	¹ 179	114, 560
	Hubbard County.....	379	242, 560
	Kittson County.....	349	223, 360
	Norman County.....	860	550, 400
	Wilkin County.....	745	476, 800
Mississippi.....	Hancock County.....	¹ 280	179, 200
Montana.....	Lower Flathead Valley area.....	¹ 312	199, 680
Nebraska.....	Colfax County.....	405	259, 200
	Dixon County.....	¹ 247	158, 080
	Furnas County.....	92	58, 880
	Harlan County.....	61	39, 040
	Knox County.....	¹ 750	480, 000
	Staunton County.....	¹ 325	208, 000
New Mexico.....	Fort Sumner area.....	118	75, 520
	Rincon area.....	75	48, 000
New York.....	Delaware County.....	¹ 185	118, 400
	Steuben County.....	104	66, 560
North Carolina.....	Brunswick County.....	297	190, 080
	Franklin County.....	50	32, 000
	Macon County.....	¹ 348	222, 720
	Montgomery County.....	498	318, 720
Ohio.....	Brown County.....	¹ 191	122, 240
	Licking County.....	¹ 158	101, 120
	Putnam County.....	¹ 119	76, 160
Oklahoma.....	Craig County.....	76	48, 640
	Grant County.....	175	112, 000
	Pittsburg County.....	415	265, 600
	Tillman County.....	552	353, 280
Oregon.....	Columbia County.....	¹ 271	173, 440
	Umatilla County.....	178	113, 920
Pennsylvania.....	Tioga County.....	¹ 310	198, 400
	Wyoming County.....	¹ 305	195, 200
Porto Rico.....	Soil Survey of.....	¹ 420	268, 800
South Carolina.....	Dillon County.....	302	193, 280
Texas.....	Collin County.....	584	373, 760
	Frio County.....	¹ 296	189, 440
	Galveston County.....	¹ 182	116, 480
	Polk County.....	¹ 515	329, 600
	Randall County.....	937	599, 680
	Scurry County.....	55	35, 200
Virginia.....	Rockbridge County.....	53	33, 920
West Virginia.....	Pendleton County.....	291	186, 240
Wisconsin.....	Barron County.....	62	39, 680
	Brown County.....	¹ 277	177, 280
	Crawford County.....	259	165, 760
Wyoming.....	Johnson County.....	68	43, 520
	Sheridan County.....	410	262, 400
Total.....		24, 561	15, 719, 040

¹ These figures do not include portions of these areas surveyed in preceding years.

TABLE 2.—Areas surveyed and mapped in the several States during the fiscal year ended June 30, 1930, and areas previously reported

DETAILED

State or territory	Work during 1930	Work previously reported	Total	
	Square miles	Square miles	Square miles	Acres
Alabama.....	1,003	53,033	54,036	34,583,040
Arizona.....	98	3,439	3,537	2,263,680
Arkansas.....	-----	15,547	15,547	9,950,080
California.....	1,115	30,551	31,666	20,266,240
Colorado.....	461	4,444	4,905	3,139,200
Connecticut.....	-----	1,704	1,704	1,090,560
Delaware.....	-----	2,276	2,276	1,456,640
Florida.....	-----	15,160	15,160	9,702,400
Georgia.....	764	34,102	34,866	22,314,240
Idaho.....	477	10,598	11,075	7,088,000
Illinois.....	-----	6,770	6,770	4,332,800
Indiana.....	684	17,490	18,174	11,631,360
Iowa.....	1,519	44,296	45,815	29,321,600
Kansas.....	969	12,933	13,902	8,897,280
Kentucky.....	126	5,020	5,146	3,293,440
Louisiana.....	188	16,769	16,957	10,852,480
Maine.....	-----	2,197	2,197	1,406,080
Maryland.....	478	12,889	13,367	8,554,880
Massachusetts.....	627	8,184	8,811	5,639,040
Michigan.....	1,851	24,179	26,030	16,659,200
Minnesota.....	2,593	9,702	12,295	7,868,800
Mississippi.....	280	29,215	29,495	18,876,800
Missouri.....	-----	37,177	37,177	23,793,280
Montana.....	312	1,701	2,013	1,288,320
Nebraska.....	1,880	51,969	53,849	34,463,360
Nevada.....	-----	652	652	417,280
New Hampshire.....	-----	1,411	1,411	903,040
New Jersey.....	-----	9,895	9,895	6,332,800
New Mexico.....	193	891	1,084	693,760
New York.....	289	26,283	26,572	17,006,080
North Carolina.....	1,193	42,186	43,379	27,762,560
North Dakota.....	-----	16,878	16,878	10,801,920
Ohio.....	468	15,721	16,189	10,360,960
Oklahoma.....	1,218	6,540	7,758	4,965,120
Oregon.....	449	14,130	14,579	9,330,560
Pennsylvania.....	615	17,645	18,260	11,686,400
Porto Rico.....	420	440	860	550,400
Rhode Island.....	-----	1,085	1,085	694,400
South Carolina.....	302	24,462	24,764	15,848,960
South Dakota.....	-----	8,286	8,286	5,303,040
Tennessee.....	-----	11,198	11,198	7,166,720
Texas.....	2,569	51,958	54,527	34,897,280
Utah.....	-----	2,419	2,419	1,548,160
Vermont.....	-----	1,175	1,175	752,000
Virginia.....	53	10,072	10,125	6,480,000
Washington.....	-----	10,752	10,752	6,881,280
West Virginia.....	291	21,044	21,335	13,654,400
Wisconsin.....	598	25,269	25,867	16,554,880
Wyoming.....	478	2,340	2,818	1,803,520
Total.....	24,561	774,077	798,638	511,128,320

RECONNAISSANCE

Alaska.....	-----	31,915	31,915	20,425,600
Arkansas-Missouri.....	-----	58,000	58,000	37,120,000
California.....	-----	32,135	32,135	20,566,400
Kansas.....	-----	39,960	39,960	25,574,400
Michigan.....	-----	1,322	1,322	846,080
Minnesota.....	-----	1,923	1,923	1,230,720
Montana.....	4,703	33,824	38,527	24,657,280
Nebraska.....	-----	53,064	53,064	33,960,960
North Dakota.....	-----	39,240	39,240	25,113,600
Ohio.....	-----	41,420	41,420	26,508,800
Oklahoma.....	1,164	-----	1,164	744,960
Pennsylvania.....	-----	41,405	41,405	26,499,200
South Dakota.....	-----	41,400	41,400	26,496,000
Texas.....	-----	152,855	152,855	97,827,200
Vermont.....	3,210	105	3,315	2,121,600
Washington.....	-----	16,540	16,540	10,585,600
Wisconsin.....	-----	14,425	14,425	9,232,000
Total.....	9,077	599,533	608,610	389,510,400

Considerable progress has been made among the several State organizations cooperating with the bureau in the proper correlation and classification of soils. Many of the States are establishing projects looking to the proper classification of soils, with special emphasis on soil profiles. Many of the States, as well as other branches of the departmental service, are recognizing the value of the present-day classification of the soil survey, and are insisting that their work be correlated with the nomenclature of this bureau.

Work on soil-profile studies has continued throughout the year and hydrogen-ion determinations have been made on more than 200 soil profiles. These profile samples were gathered throughout the United States, and most of them represent recognized soil types that were collected for correlation purposes. Altogether 835 samples from different horizons have been studied and their reaction values determined.

On 45 soil profiles special work was done on samples in both the moist-field condition and in the air-dry state to show the effect of air-drying on the hydrogen-ion concentration of the soils. It is expected that the results of this work will show the correlation between hydrogen-ion concentration and soil type, and throw some light on the question of how these are related to different climatic conditions.

During the summer of 1929, in cooperation with the Wisconsin Geological and Natural History Survey, studies were made of profiles of a number of Wisconsin soils, which will prove of great assistance to the bureau in the correlation of soils of that region. A total of 23 soil types was examined, and a complete record of the results is on file in the office of the soil survey.

The flood-control plan adopted by the War Department for the lower Mississippi Valley contemplates the building of levees along the river and the provision of a certain number of spillways to take care of excess water when the pressure on the levees becomes dangerously heavy. The tentative plan, so far as it concerns the Bureau of Chemistry and Soils, contemplates the preliminary survey by the soil survey of five or six strips, 2 miles wide, across these spillways, for the purpose of obtaining a basis for the classification and evaluation of the land. A special appropriation from the War Department was transferred to this bureau for the work which is now in progress. The soil survey is also cooperating with the Indian Service.

SOIL INVESTIGATIONS FOR LAND-CLASSIFICATION PURPOSES

Early in 1930 preliminary investigations were started in cooperation with the Bureau of Reclamation, Department of the Interior, looking to the preparation of plans for the proposed soil survey and land classification to determine the economic feasibility of the all-American canal through southern California. This preliminary work has been completed and additional investigations are being undertaken for the Bureau of Reclamation on soil questions which involve the transfer of water from the Sacramento to the San Joaquin Valley. One of the important conditions to be determined is the area of soil suitable for irrigation in both valleys. This study is still in progress.

During the summer field season 1929 an examination was made of the soils in the Flathead project in Montana for the Bureau of Indian Affairs in order to classify the land with respect to requirements for the development of an agricultural program. Similar work is in progress on the Wapato project of the Yakima Indian Reservation in the Pacific Northwest.

PEAT AND MUCK INVESTIGATIONS

The activities in peat investigations during 1929-30 continued the main lines of field and laboratory work indicated in the subproject. The outstanding results of the fiscal year may be summarized briefly as follows:

In its visualization of regional peat investigations the bureau has outlined the following nine regions as being of major importance, each of which should be considered as a whole:

1. The New England peat areas.
2. The Atlantic coastal peat areas.
3. The Florida and Gulf States peat areas.
4. The Great Lakes peat areas.
5. The Mississippi River peat areas.
6. The Columbia River and northern Pacific coastal peat areas.
7. The California and southern Pacific coastal peat areas.
8. The mountain Alaskan and alpine-boreal peat areas.
9. The tropical peat areas.

Actual examination has been made this year of the distinctive characteristics of important peat soils in Florida, North Carolina, Maine, California, and Washington. Their inherent structural differences and the conditions which tend to determine productive power have been reported in a series of papers which have appeared in several scientific journals.

Various specific laboratory activities dealing with peat materials and profile sections have been thrust on this bureau by practical necessity owing to the increasing requests of scientific, agricultural, and other agencies for the botanical identification of different peat samples. The nature of the problems calls for painstaking professional skill, the development of uniform tests and methods of microscopic analysis, and the standardization and illustration of plant remains as types of peat.

SOIL-EROSION AND MOISTURE-CONSERVATION INVESTIGATIONS

During the fiscal year the principal phase of the work of the Bureau of Chemistry and Soils in connection with soil-erosion and moisture-conservation investigations was centered about the selection of suitable experimental station sites in the defined major soil regions, where erosion and water losses are very serious agricultural problems; the installation of necessary experimental equipment for measuring these losses from varying slopes on definite soil types existing under natural, undisturbed conditions; and the operation of these experimental installations by highly trained specialists. The main purposes of these investigations are twofold: (1) It is necessary to have accurate quantitative measurements of the effects of soil washing and the run-off of rainfall for definite, extensive, and

important soil types existing under varying conditions of slope, crop use, and crop treatment, in connection with the needs of the engineering problems of erecting erosion-prevention and control structures, and for devices intended to increase the storage of water within the soil for subsequent crop use; and (2) it is necessary to save the measured erosional débris in order that it can be stored and properly exhibited in an educational way on the spot where the processes involved have been in action and the measurements of the effects made.

In connection with the operation of these undisturbed soil plots similar comparative measurements are being made on (1) virgin soil and (2) on soil from which the A horizon, or topsoil, is removed down to the subsoil. This will give a measure of the rate of erosion and amount of water storage under opposite conditions of eroded soil (or the equivalent of eroded soil) and uneroded soil, and also comparative crop values for these extremes.

A second phase of the station work is the measurement, on 1-acre plots, of the soil-erosion and moisture-conservation effects of various tillage operations, under field conditions such as subsoiling, leaving the ground in a condition of rough fallow, and the practice of planting row crops up and down the slopes and along the contours of slopes. For accurate measurements of the effects of erosion and run-off from the smaller plots it is necessary to install a system of substantial tanks of sufficient capacity to take care of the maximum 48-hour rainfall for the region, as based on available weather records and the estimated run-off, which latter is a variable dependent on slope, soil type, length of plot, and character of usage. These tanks and plots must be erected and protected with such scrupulous care and exactness that elements of leakage, overflow from abnormal precipitation, and undue soil transportation are minimized to the utmost limits; and the tanks must be carefully calibrated for the purpose of precise and expeditious measurements.

Measurements of run-off and wash-off on the various other experimental plots, such as the 1-acre plots, will be handled with Ventura flumes and accurate sampling made of spill water to determine silt losses.

Another important phase of the station work centers about measurements of water losses from and storage within the soil, as affected by soil type, with particular emphasis on the relation of the soil horizons, separately and collectively, to water losses, and storage within the soil, as affected by soil type. In order to work out this phase of the investigation studies will be made under a large variety of surface conditions and crop treatments on definite types, with and without erosion-prevention and moisture-conservation structures, in small plots and large fields. It is expected that these studies will throw light on various problems of rainfall penetration, evaporation, and circulation under conditions of varying rainfall intensity, time between rains, soil aridity and humidity, exposure, slope, soil treatment, depth to water table, soil horizontal characteristics, and depth of the soil profile. A number of problems relating to this highly important agricultural feature of rainfall disposition and the effect of artificial devices in modifying its disposition have never been satisfactorily worked out, and probably never could be except by studying the factors concerned, in the field. It is known that the

soil type, with its differing component horizons, markedly influences the run-off, penetration, absorption, and circulation of moisture, and it is therefore necessary that highly trained soil specialists, familiar by experience with soil types and soil morphology, should study the problem in the field. Such men are being put on this work.

The greatest possible care is being exercised in locating sites for the stations. Sufficiently large tracts of land of uniform soil conditions must be found, and these must have a variety of slopes. Other necessary features are a not too severely washed condition to begin with, absence of noxious weeds, location on a good highway, and nearness to towns with housing facilities for the personnel.

The regions are being thoroughly examined in order to find suitable locations that can be easily reached by farmers, extension people, bankers, merchants, teachers, and others at any time of the year. It is expected that soil-saving and water-conservation schools will be held at these stations when the work has sufficiently advanced. Already visitors are daily coming to see the work at the stations in Oklahoma and Texas, and this desirable feature is certain to grow.

Searching out the proper soil and topographic conditions requires the services of our most widely trained soil scientists. In one region the search extended in considerable detail to 15 counties and in a reconnaissance way to other counties.

Additional station work will require the keeping of accurate rainfall, sunshine, wind, and temperature records, and the measurement of atmospheric and ground dust accumulations, the taking of numerous soil samples, and the making of moisture determinations from the various soil layers.

The reconnaissance erosion survey of the Nation is being continued, although the time required by the other phases of the investigation has not allowed the desired progress on this important project, the principal purpose of which is to determine the geographical distribution of eroded lands, the types of erosion, and the extent of the damage. Detailed erosion surveys are being made of all the experimental stations before actual operations begin.

In the Washington laboratory chemical and physical analyses are being made and research work carried on in connection with measurable properties of soils of relatively low and high erosivity. In connection with our recent soil surveys and explorations in the Tropics, various soil types have been found which possess markedly different properties of structure, resistance to erosion, swelling, shrinking, etc. Studies of tropical soils of lateritic character, such as those of Costa Rica and eastern Cuba, have shown that these soils resist washing in a remarkable degree, absorb most of the heavy regional rainfall, do not scour well over the moldboard of plows, show but slight stickiness, and crack but little on drying. Somewhat similar characteristics apply also to certain important soil types of the United States, as the Davidson, Nacogdoches, and Aiken types. The plastic clays, such as the Iredell, exhibit, to a marked degree, properties opposite to those of the lateritic group or the clays of low silica. Laboratory investigations of samples of these indicate the possibility of measuring the erosivity of these clay types by determining the relative dispersability of their colloids.

The work for the fiscal year 1931 will continue along the line of that carried on during 1930. With the funds requested it is expected to get under way experimental stations for an additional number of major erosion regions in which stations could not be equipped and operated with the funds available in 1930. This work of establishing these key stations and getting them into operation will be pushed as rapidly as funds allow. The erosion survey and other phases of the work will go forward, but the greatest emphasis will be placed on the completion of the regional erosion stations.

SOIL-FERTILITY INVESTIGATIONS

POTATO-SOIL AND FERTILIZER INVESTIGATIONS

Field work during the fiscal year was conducted on prominent soil types in the leading potato-producing sections of Maine, New Jersey, New York, Pennsylvania, and Virginia. These investigations are being carried on in cooperation with the agricultural experiment stations of the first four mentioned States, and with the Virginia Truck Experiment Station.

In the various commercial potato-growing regions in which the fertilizer work is being conducted, close contact has been maintained with potato growers and their organizations. In a majority of cases the fertilizer experiments have been made on land assigned by leading farmers. Through these contacts the purpose of the work and the results obtained are more definitely realized and appreciated by the people of the potato-growing sections.

The results obtained during the fiscal year continue to furnish practical evidence with respect to (1) the proper proportion of nitrogen, phosphoric acid, and potash to employ for potatoes on different soil types, (2) the kind and amount of nitrogen materials to use, (3) the kind and amount of potash materials to use, (4) the amount of phosphoric acid to use in potato-fertilizer mixtures, and (5) the most economical rate of application of fertilizer for potatoes on specific soil types and under different farm-management systems. These are results of immediate importance to potato growers and represent important accomplishments.

The 1930 results are giving further indications concerning the influence of fertilizer compositions and ratio on culinary quality and shape of potatoes.

The influence of fertilizers on fresh-cut and suberized seed stock showed clearly the advantage of suberization. Fresh-cut potato seed pieces were much more easily injured than the suberized stock. This is of importance to potato growers on light soils or where the fertilizer fails to become properly mixed with the soil.

SUGAR BEETS

The soil-fertility investigations with sugar beets during the past year have included a study of the various soil types as to their adaptability for growing sugar beets, together with the fertilizer requirements of those soils. Ten fertilizer experiments located in 7 of the 18 States in which sugar beets are grown were the basis for study of these problems. In addition to these experiments, five other fer-

tilizer experiments were conducted cooperatively with the office of western irrigation agriculture and the office of sugar plants, Bureau of Plant Industry.

The value of these experiments is accentuated by the low cost of the plant-food element most needed and the results to be obtained from as small applications of fertilizer as 125 to 200 pounds per acre of a 16 to 20 per cent phosphate. Where the treble superphosphate is applied not more than 100 pounds per acre are generally necessary. The cost of the fertilizer to the grower ranges from \$2 to \$2.50 an acre. With increased yield of 3 tons per acre, at \$7 a ton, the gross profit is about \$18 an acre—equivalent in value to a good wheat crop. In 1922, when the soil-fertility work with sugar beets was started, no fertilizer was used on sugar beets in Colorado, the largest and most profitable sugar-beet territory in the country. The American Beet Sugar Co. was the first to adopt a fertilizer program based on results furnished them from experiments conducted by the bureau in the Arkansas Valley. The practice more than doubled with each succeeding year's results and recommendations. During the past year the Great Western Sugar Co. put on a program of "phosphate for sugar beets" with recommendations to all of its growers to use it. Such recommendations are far-reaching and will no doubt lead to complications, as no two types of soil behave alike, where the same kind and amount of fertilizer is applied to each.

In order to safeguard the growers there is need to extend the fertilizer work to include all the important soil types on which sugar beets are grown. No definite information is available at this time to show the acreage of sugar beets that will be fertilized this season, but it has been estimated at 200,000 to 250,000 acres, which, with an increased yield of 3 tons per acre, would raise the value of this year's crop by \$5,000,000 less the \$500,000 expended for fertilizer.

SUGARCANE

The accomplishments for the fiscal year include soil and fertilizer studies in the field and chemical studies with soils and fertilizers in the laboratory at Houma, La. Before the fertilizer experiments were started in 1930 a reconnaissance survey of the entire sugar belt of Louisiana was made to determine the probable extent and location of the various soil types on which sugarcane is grown. A large number of samples of soil were collected and sent to the laboratory at Houma where a study of the hydrogen-ion reaction and other properties was made to determine, if possible, the limiting factor for growth of sugarcane on the various soil types. During the course of the reconnaissance survey a tentative soil map was prepared showing the probable extent of the different types of soils of the sugarcane belt. After making the reconnaissance of the soils of the sugarcane belt, fields were selected typical of each of the main soil types which were used for fertilizer test plots.

Seven test fields, picked for uniformity of soil type, were established at strategic points on the dominant soils of each area. Five mixtures containing different proportions of nitrogen, phosphoric acid, and potash were replicated from two to four times. Plant cane gave very little response to fertilization, owing to the residual effect

of green-manure crops. The results from first and second stubble, however, indicate that nitrogen is the most essential element, though mixtures of nitrogen and phosphoric acid and nitrogen and potash gave very satisfactory returns on certain soil types. Applications of 40 pounds of nitrogen per acre on first stubble grown on Yazoo silt loam showed an increase of 11.8 tons per acre over check, while second stubble on Yazoo loam gave an 11.1-ton increase. The phosphoric acid and potash mixture gave practically no increase over check.

CONCENTRATED-FERTILIZER INVESTIGATIONS ON PROMINENT SOIL TYPES

In a majority of cases the field work outside of Washington is conducted in direct cooperation with leading farmers. The crops employed as indicator crops are cotton, potatoes, sweetpotatoes, citrus fruits, corn, tomatoes, peas, beans, and sweet corn.

During the fiscal year results of importance were obtained demonstrating still more conclusively the crop-producing and economic value of concentrated fertilizers. Actual experimental field work in close contact with farmers and their organizations in some sections has enabled them to appreciate the fact that plant-food concentration does not mean less yield. It has been feasible, as a result of the field studies, to bring to the attention of many farmers in a number of crop regions the economies to be effected by the use of high-analysis fertilizers, such as savings on mixing materials, bags, freight, hauling, and handling.

At the same time the field work during 1930 has given positive evidence of the necessity for exercising the utmost precaution in using concentrated fertilizers on soil types of a sandy nature. It is on such soils that the importance of placement and distribution of concentrated fertilizers is clearly evident. The results which are being obtained have enabled the bureau to make more definite recommendations with reference to the use of high-analysis materials and their mixtures than it was heretofore possible to do. It has been found in Aroostook County, Me., for example, that the use of concentrated fertilizers for potatoes has increased considerably during the past year owing largely to the bureau's cooperative work on concentrated fertilizers with the Maine Agricultural Experiment Station, a report of which was issued by the Maine station. This is true of other sections, primarily owing to the work conducted by this bureau.

COTTON ROOT-ROT INVESTIGATIONS

The following soil investigations with the cotton root rot of Texas are in progress: The influence of fertilizer, rare elements, and soil amendments; influence of deep, shallow, and thorough tillage; and the influence of the physical and chemical characteristics of the soil on the root rot of cotton. A laboratory and offices are located in the University of Texas building at Austin, but field activities cover the entire black-land belt. Fertilizer and soil-amendment experiments were made at the United States Cotton Breeding Station, Greenville; United States field station at San Antonio; Texas Cotton Root Rot Experiment Station, Temple; and with 12 farmers in the black-land belt.

During the past season a series of 14 major field experiments were conducted in the black-land region of central Texas to test the effect of a variety of fertilizer ratios on cotton grown under conditions of root-rot infestation. The experiments were so distributed as to cover the range of variations in soil type and climatic conditions prevailing in the region and were carried out in conformity with the farm practice prevailing in the several localities.

In general, significant increases in yield resulted from the application of mixtures containing the higher proportions of phosphate, together with some nitrogen, although in some instances the greatest response was to the higher proportions of nitrogen in the presence of phosphate. In a number of cases the increases in yield were in excess of 75 per cent. The returns from such increased yields counterbalance or even measurably exceed the losses due to root-rot infestation. In several experiments phosphatic fertilizers appreciably accelerated maturity of the crop, offering promise of evasion of losses from root rot by maturing the cotton before killing of plants takes place. The prospects of indirect control of cotton root rot by use of suitable chemical fertilizers appear hopeful.

In most of the experiments considerable increase in yield of cotton has resulted from the use of fertilizers. A noticeable influence of certain fertilizer materials was effective in hastening the growth, fruiting, and maturing of cotton, and in delaying the appearance of cotton root rot. On many of the soils worked with, the cotton which was fertilized produced mature bolls, equivalent to from one-third to one-half bale of cotton, before any root rot started, whereas on the unfertilized areas no mature bolls had formed when root rot became established.

The tillage experiments under way are showing some promising results. When the heavy, stiff land is subsoiled to a depth of 16 or 18 inches and the intermediate area between the surface and this depth is chiseled to break up the hard compact mass and allow thorough aeration, considerably less root rot has appeared. Subsoiling to a depth of 18 inches, carried out in October, 1928, on a cotton field highly and uniformly infested with root rot, resulted in a reduction of infestation in 1929 to one-third of that occurring on adjoining nonsubsoiled land.

There is a marked correlation of root rot with the character of the soil in the black-land belt. Eroded fields where the subsoil is exposed and where tillage is poor are much more subject to loss of cotton from cotton root rot than fields which are well terraced and well cultivated. Surveys of definite areas which are spotted with root rot show that the root rot has caused most loss where the soil is shallow and the subsoil near the surface.

SOIL-FERTILITY AND FERTILIZER INVESTIGATIONS WITH PECANS

A field laboratory and office is located at Shreveport, La., and is maintained in conjunction with offices of the Bureaus of Plant Industry and Entomology. A chemical study and field studies of pecan soils of the region are under way to determine the soil's chemical and physical characteristics as correlated with pecan tree growth, nut yield, and quality. An experiment is in progress at Albany, Ga., using varying amounts of nitrogen in a complete

fertilizer, and one in cooperation with the Bureaus of Plant Industry and Entomology with fertilizers, cover crops, and tillage methods to study these factors on tree conditions and nut yield. Two experiments are in progress in Florida, one on Norfolk sand at Jacksonville, and one on Bladen sandy loam at Baldwin, to determine the best fertilizer formula for pecans on these soils. Results to date indicate that these Florida soils require more potash for pecans than the Georgia soils of the Albany section.

The work in the southeastern belt of Georgia, Florida, and Alabama has been in progress since 1918 and has led to the formulation of a fertilizer practice which is being generally followed by growers in these regions with increased yields.

FERTILIZER INVESTIGATIONS ON PROMINENT SOIL TYPES

Investigations were started in 1930 to study the fertilizer requirements of various soil types in North Carolina for sweetpotatoes and potatoes, in cooperation with the North Carolina Agricultural Experiment Station and potato growers organizations in the State. Experiments have been completed with potatoes on Norfolk sandy loam and Dunbar sandy loam at New Bern, N. C. The investigations showed that potatoes could be produced more economically with much less potash than was being used in the locality on these soil types, and resulted in a great saving to the potato growers. A fertilizer mixture composed of 5 to 6 per cent nitrogen, 7 per cent phosphoric acid, and 4 to 5 per cent potash has given best results.

Sweetpotato experiments have been completed on Portsmouth sandy loam at New Bern, N. C., Norfolk sandy loam at Beaufort, N. C., and Cecil clay loam at Newton, N. C. In these investigations a fertilizer mixture consisting of 4 per cent nitrogen, 7 to 8 per cent phosphoric acid, and 8 to 10 per cent potash gave best results. A 4-8-10 formula is used generally in these communities, as a result of the work, with largely increased yields.

Experiments have been in progress for five years with sweetpotatoes on Norfolk loamy fine sand in Currituck County, N. C. This county produces the largest quantity of early sweetpotatoes of any section of the United States. A fertilizer mixture containing 4 per cent nitrogen, 8 per cent phosphoric acid, and 8 per cent potash has given best results and its use has been adopted by growers, resulting in largely increased yields. The results of the concentrated-fertilizer studies to date are published in North Carolina Experiment Station Bulletin No. 252.

Fertilizer experiments with peaches were begun in 1922 in cooperation with the Georgia Agricultural Experiment Station. The results show that the maturing of peaches can be varied from 10 to 20 days by the use of varying amounts of nitrogen and potash. High phosphate fertilizer hastens and high nitrogen fertilizer delays the maturing of peaches.

THE OXIDATION OF SOME ORGANIC COMPOUNDS IN SOIL

The work on forms of nitrogen in soils has developed along two lines: (1) A further study of hydrolysis products, and (2) a continuation of the study of compounds by actual isolation and identification.

The fact that soils suspended in dilute alkali absorb oxygen when air or oxygen is passed through such suspensions, with the formation of an alkali carbonate, has been recorded and discussed in a bulletin in press. The continuation of work along this line has indicated a possible connection between this behavior and the presence of uronic acids, and it is believed that further consideration of this possible connection may throw light on the mechanics of the process just referred to.

Oxidation of soil organic matter by hydrogen peroxide has produced some interesting results. It has been shown that when soils are treated with hydrogen peroxide until no further action takes place there is left an insoluble residue which still contains carbon and nitrogen. Investigation of the nature of the nitrogenous material in such residue from one soil, Chester loam, has shown that it contains a compound or compounds similar to those classified in the indol group.

SOIL REACTION AND OXIDATION STUDIES

In general, this work has comprised the testing of all new methods or modifications of old ones proposed in the literature for the determination of hydrogen-ion concentration. One of the results of this work is the conclusion that the quinhydrone electrode can not be recommended for general use on soils. It is not applicable to soils that are alkaline and it is not accurate on soils containing much manganese. Inasmuch as nearly all soils contain some manganese and it is not definitely known how much manganese is necessary to make the method inaccurate, the only safe plan is not to use it on soils.

A method for determining chlorides electrometrically has been developed, and it is believed this will be just as accurate and very much more rapid than the method of extraction and titration.

GREENHOUSE INVESTIGATIONS

Considerable greenhouse work has been carried on during the year in conjunction with field problems. Some large-scale pot experiments to study the comparative effectiveness of phosphate materials on different crops were conducted and suggest that, in the main, the more readily available phosphate materials are superior to the less readily available phosphate carriers. Final conclusions are reserved until more data are obtained.

Studies with alunite and polyhalite as potash sources for oats and wheat indicate from results obtained during the fiscal year that polyhalite, in particular, compares favorably with potassium sulphate as a source of potash in mixed fertilizers.

MANGANESE STUDIES

Manganese studies are being carried on as a sequel to the greenhouse trials in which five different commercial manganese-carrying materials were tested as to their value for supplying that element to tomato plants grown in the manganese-deficient calcareous glade soils of Florida.

In all, 25 plant samples and 5 of the ripe fruit were analyzed for their content of moisture, ash, and manganese. The fresh and dry weights also were recorded. These plant samples analyzed represent check plants, control plants receiving known quantities of manganese, and plants grown in pots containing varied quantities of the several manganese carriers; also one set receiving magnesium sulphate but no manganese. The series represents plants grown for different lengths of time subject to the several soil treatments.

The general fertilizer used and the Dade County soil were also examined for their manganese content and the fertilizer, soil, and each of the manganese carriers have been examined for water-soluble manganese.

STRAWBERRY SOIL FERTILITY AND FERTILIZER INVESTIGATIONS

A field laboratory and office is located at Chadbourn, N. C., in conjunction with the Bureaus of Entomology and Plant Industry. A chemical study has been made of various types of soils on which strawberries are growing and plant conditions correlated with the soil's chemical and physical factors. The soils of the Chadbourn section vary widely in range of acidity. Field experiments are being made to study the influence of various nitrogen sources, the ratio of nitrogen, phosphate, and potash, and amounts of fertilizers. Investigations in pots and field are also being made of the effects of rare, essential chemicals, as manganese, iron, zinc, copper, etc. Manganese has had an appreciable effect on the plant, and there has been noted a correlation between the phosphate content of fertilizers and the amount of dead caps of strawberries. Especially good results have been secured with concentrated fertilizers composed of synthetic materials. So far as taste and flavor of the berries are concerned, these seem to be most favorably influenced by nitrogen.

SOIL MICROBIOLOGICAL INVESTIGATIONS

As a result of work in soil bacteriology done by the bureau and in the State colleges, inoculation of leguminous crops with nitrogen-fixing organisms is now widely accepted. The annual commercial distribution of cultures for this purpose is valued at about \$1,000,000 and probably affects crops valued at \$50,000,000. As directed by Congress, the Bureau of Chemistry and Soils inspects all the products offered for this purpose. This distribution was found divided among 14 State institutions and 22 commercial organizations. A list of 24 distributors producing satisfactory products was prepared and distributed to the public. Fraudulent and unsatisfactory products are being eliminated by this inspection. The bureau continues to support the distribution of high-grade cultures by maintaining a tested collection of types available to all applicants.

The decomposition of crop residues, natural vegetation, and waste products of all kinds in the soil depends on the microorganisms present. With a thousand types of soil described in the United States, the task of utilizing the power of this microbiological soil population in producing conditions favorable to crop production is immensely complicated. Conspicuous types of depleted acid soil have been selected, and the possibility of regenerating their produc-

tivity by fertilizer and the proper stimulation of the soil population has been demonstrated. The rate and nature of the decomposition processes which restore tillable conditions in soils which have become nearly worthless are being worked out on an experimental scale. The response in terms of increased crop production is fully demonstrated.

Along with the study of the function of microorganisms in mass, study of the presence and significance of special groups of organisms has shown one group, the slime molds, or Myxomycetes, not hitherto recognized in general agricultural work, to be present and active in the decomposition of plant residues on and in the soil.

INSPECTION OF SOIL INOCULANTS

Commercial preparations of nodule and other soil bacteria presumably beneficial to plant growth have been collected under more than 50 trade designations to the extent of more than 500 samples. In addition to these, 65 samples of seed inoculated with material of several kinds have been obtained.

The practice of preinoculating seed is new and is not recognized as a satisfactory method by specialists in soil bacteriology, the chief objection being that the organisms are subjected to severe drying under the circumstances and that the greater part of the material added falls from the seed. Finely divided soil mixtures, charcoal, and pulverized humus are used as carriers for the inoculants to be applied dry. Soil, sheep manure, peat, sand, nutrient broth, and agar are the chief materials employed in preparing cultures for application with water. Field comparisons of wet and dry applied materials have given better results with the former.

The samples collected, whether seed or cultures of organisms in packages, have been examined or are in the process of examination to determine their flora of microorganisms, principally their content of legume-nodule organisms, and their ability to produce satisfactory nodulation and plant vigor on the legumes for which they are intended. Since the last report several of the questionable cultures have been removed from the market and their manufacture evidently discontinued. The quality of the samples of inoculating material for legumes of the major producers continues fairly good, but there are several small producers who manufacture practically worthless cultures, none of which possesses as much efficiency as a fairly rich soil. Information concerning the quality of inoculants has been disseminated by letter, published lists, through the extension service, and by personal contacts. Companies with which cooperation is possible have been notified of defects found in their material.

ROOT NODULE BACTERIA

Studies in cooperation with the University of Wisconsin have indicated the variability in efficiency of soybean nodule organisms in fixing nitrogen. A similar condition was found in connection with Austrian winter peas at a livestock farm at Jeanerette, La. Bacteria from vigorous and weak plants of this field, the latter predominating, were tested in the greenhouse on the same legume and on two different occasions reproduced a condition similar to that

noted in the field. This work has been published under the title "A Failure of Austrian Winter Peas Apparently Due to Nodule Bacteria," in the Journal of the American Society of Agronomy.

At present cooperation is in progress whereby the department is testing the materials which are used by different cooperative farmers' organizations.

COOPERATION WITH THE EXTENSION SERVICE

During the past year approximately 6,000 cultures of nodule bacteria for treating seed of alfalfa, red clover, cowpeas, soybeans, vetch, and other legumes have been distributed to farmers and experimenters, either directly in response to written requests or through agricultural agents. In some cases where particular problems have arisen and no satisfactory source of inoculation was available, county agents have been supplied liberally with material for demonstration purposes.

A list of firms distributing inoculating material was compiled on October 2, under the title "Sources of Legume Bacteria Cultures" and distributed to those inquiring for such information.

MICROBIOLOGICAL STUDIES OF SELECTED SOILS

Studies with Leonardtown and Collington soils has been continued. Additional data obtained showed that the decomposition of green manures in the soil was largely local in nature.

It was found that numbers of bacteria increased tremendously in the green manure itself. Fungi increased in numbers to some extent. Protozoa increased as numbers of bacteria increased. No increase in numbers of any of these microorganisms was observed in the soil proper. A decided increase in pH and in NH_3 nitrogen took place in the green manure; as the decomposition processes slowed down the pH and NH_3 nitrogen content decreased while a gradual accumulation of NO_3 nitrogen took place. This NO_3 nitrogen tended to concentrate in the upper half inch of soil.

Carbon dioxide evolution was determined, and an apparent correlation with rate of decomposition was found.

In addition to microbiological studies on Leonardtown clay loam and Collington fine sandy loam inaugurated two years ago, an experiment has been started for the purpose of obtaining data on the maintenance of nitrogen in a number of selected soils.

An apparatus has been devised which is suitable for the determination of amounts of CO_2 given off by the soil and which can be used both in the greenhouse and in the field. The apparatus and its application has been described in a paper published in Soil Science under the title "A Method for Measuring Carbon Dioxide Evolution from Soil."

THE FUNGI OF THE SOIL

In connection with survey work in the field, plasmodia of the Myxomycetes were found, and repetition and extension of this work developed the information that this great group of organisms is much more abundant and active than has hitherto been supposed.

The amoeboid and plasmodium phases of these organisms have been shown to be abundant during the months from December, 1929, to April, 1930, all the way from the tips of decaying vegetation several inches above the soil to the level of the roots several inches in the soil. Cultures have been isolated and experiments for the determination of the part they play in soil economy are already in progress. A paper on this subject will appear in an early number of the *Journal of the Washington Academy of Sciences*.

Collections of saprophytic fungi from the soil and other sources continue to be submitted for identification from different workers in North America and abroad. Such assistance is given wherever possible. The Public Health Service continues to refer their inquirers and to send their own cultures of molds charged with pathogenicity in human cases to the bureau for identification. Since no other laboratory in the service seems prepared to handle these cultures, the questions have been answered as far as facilities allow.

The Monograph of the *Penicillia* has been completed and was published in book form in January, 1930. Plans have been made to extend in every way possible the study of fungi as active agents in soil processes.

SOIL CHEMISTRY AND PHYSICS INVESTIGATIONS

The work of the bureau in soil chemistry and physics is of two types: Service duties carried out at the request of other governmental agencies and research on soil topics.

During the fiscal year the service duties required a very large amount of time and labor and involved making about 1,300 examinations for the soil survey, the Bureau of Plant Industry, the division of soil fertility, smelter-fumes investigations, Bureau of Public Roads, phosphate investigations, Forest Service, Veterans Bureau, War Department, Bureau of Animal Industry, Bureau of Fisheries, Michigan Agricultural College, Post Office Department, and various other miscellaneous purposes. Many of the routine examinations are utilized by the bureau in supplementing research or confirming conclusions arrived at by other methods. They have also assisted in giving accurate and adequate replies to inquiries from the general public.

PHYSICAL EXAMINATIONS

During the year work was completed upon a pipette method of mechanical analysis of soils, based on improved dispersion procedure. This method has not only resulted in a more accurate measure of the texture of soils but has lessened the cost of operation. The main investigation has resulted in the publication of Bulletin 170, and certain aspects have been published in the *Journal of the International Society of Soil Science*. As a corollary of this investigation, a method of mechanical analysis of ground phosphorus and marl, and a discussion of the method and its application, has been accepted for publication as a technical bulletin.

In connection with the work of the bureau on soil erosion, a very careful study of the properties of soils which influence erosion has been made and has appeared as Technical Bulletin 178. The inves-

tigation has shown that the properties of major importance in soil erosion are the dispersability of the colloid and the moisture equivalent of the soil. Further studies are being made upon means of alteration of these and other properties. In the same connection, a study has been made of a laboratory method of determining the percolation rate of water through soils in the field. This investigation has thrown considerable light upon the variations of the permeability of soils, both in respect to their composition and their previous treatment, and the results promise to be useful in the problems of erosion.

Studies have been carried out on the optical properties of soil colloids in collaboration with the fertilizer and fixed nitrogen unit, with the result that much light has been thrown upon the constitution of the soil colloids.

Research is in progress upon the use of a supersonic oscillator in the dispersion of soil particles and is approaching completion. A very careful investigation of the soils upon which are located the erosion experiment stations is being made, and the results will be available for the assistance of those carrying on the field experimentation.

A study is being made on the osmotic character of soil colloids, but has not yet reached a point where definite conclusions can be drawn.

CHEMICAL INVESTIGATIONS

An investigation of the chemical effect of soil submergence in water has been completed and the results published in *Soil Science*. It has been shown that not only are toxic quantities of iron and of manganese developed in the soil solution, and that the soil is depleted in its calcium content, but that large quantities of gases are also produced from the organic matter, and include such normally toxic materials as hydrogen sulphide and carbon monoxide.

Continued studies on colloids have resulted in the publication of two bulletins and two articles in the *Journal of Agricultural Research*.

It has been shown that acid anions are absorbed by soil colloids, to a very slight degree, indeed, but that such absorption does occur, and in general is more marked in soils of the lateritic type than in the less completely decomposed soil materials of other soil types. A study of the chemical composition of the colloid isolated from certain soil types points to the possibility of fractionation of the colloids in such a way as to reveal differences in composition and throw light upon the process of development of such material. This investigation is being actively prosecuted and has already shown important results. The work will not be completed for a year or more.

The two bulletins above referred to have to do with the constancy of composition of the colloid of a given soil series and with the wide differences shown by the colloids derived from different soil series. This work is important not only as an aid to, and a justification of, the results of soil classification, but as a basis of variation in treatment of soils of different origin.

An investigation is being made of the effect of colloid material on phosphorus assimilation by plants. This investigation, while not yet complete, has shown that the different colloids are quite unlike in their retarding effect upon phosphorus assimilation and that this

effect is more or less closely associated with their silica sesquioxide ratio.

A very extensive investigation of the chemical composition and physical characteristics of three widely divergent types of peat has been made. An effort was made so to conduct these measurements that they may become the basis of comparison with future peat investigations, and the work is being continued with the object of ascertaining how normal organic reactions may be induced in peat when mixed with soil, and in this way accentuate its uses.

Investigations are under way on the causes of lack of productiveness of certain soil types of known infertility, and also on the chemical causes of differences in productivity of different samples of the same soil type. These investigations have not been carried far enough at present to warrant statements concerning the ultimate result to be expected.

FERTILIZER AND FIXED NITROGEN INVESTIGATIONS

Plant food is constantly being lost from our cultivated soils in large quantities, chiefly through the removal of crops but also as a result of leaching, erosion, and other miscellaneous agencies. The growing tendency to farm more intensively and produce larger yields per acre is further depleting the natural plant-food resources. Fortunately, nature has provided for the restoration of a part of the food removed, but the maintenance of soil fertility at a high level of production requires in addition that the farmer artificially supply certain of the elements removed. The substances which need to be considered in such a fertilizer program are nitrogen, phosphates, and potash.

The chief aim of this unit is to assist the farmer and the fertilizer industry in devising methods for the most economical production and use of these fertilizer ingredients. This entails the use of much fundamental chemical data that can only be procured by a comprehensive research program. The research activities are now concentrated to a large extent on the development of new manufacturing processes and the improvement of those already in use; the production of new compounds; the study of the practicability of using new sources of raw products or of utilizing by-products from other industries; and the determination of the chemical and physical properties of the final products. An intensive study of the various phases of fertilizer production is especially urgent at present in order that this country may no longer be dependent on foreign sources; it is also necessary for the industry to keep abreast of that abroad and be able to meet increasing foreign competition.

NITROGEN

The nitrogenous ingredients used in fertilizers have until comparatively recently consisted chiefly of organic materials from plant and animal sources, sodium nitrate from the natural deposits in Chile, and ammonium sulphate produced as a by-product from the coke industry. It has become increasingly apparent, however, during the last 25 years that in order to insure a supply of nitrogen sufficient to meet national demands of either peace or war an addi-

tional source of nitrogen is essential. European countries early took the lead in this field by pioneering the development of various nitrogen-fixation processes. This bureau has been endeavoring to promote the growth of such nitrogen-fixing industries in the United States. The three nitrogen-fixation methods that have been given most consideration are the arc, cyanamide, and synthetic ammonia processes. Research at present is confined to the latter, since the possibilities of cheapening the cost of ammonia production by this method seem much more promising. Such rapid progress has been made in recent years that it seems probable that this country will soon be entirely independent as far as nitrogenous fertilizers are concerned. Last year approximately 100,000 tons of ammonia were produced in this country from atmospheric nitrogen. This bureau has contributed in a major way to this industrial development by its own researches, by closely cooperating with the industry, and by training a considerable percentage of the personnel now responsible for production.

AMMONIA SYNTHESIS

In the production of ammonia by the synthetic process the pure nitrogen and hydrogen gases are mixed in the proper proportions and subjected to high temperatures and pressures in the presence of a catalyst. The catalyst, consisting of iron containing small percentages of such compounds as aluminum oxide and potassium oxide, greatly increases the rate at which the two gases combine. In fact, nitrogen gas is so unreactive that the whole process depends directly on the presence of a material that can activate it. A considerable part of the early research activities of this laboratory was devoted to the discovery of suitable catalytic materials. The research activities are now more concerned with the study of the factors which influence and determine the activity of these substances. By studying the fundamentals of catalytic reactions a sound basis is established for the improvement of catalysts and incidentally for safeguarding the future of the nitrogen industry. Much of the information being obtained is also directly applicable to numerous other chemical industries where catalysts are in common use.

The recent investigations have gone far toward determining the mechanism by which ammonia catalysts function. The indications are that the iron catalysts are particularly effective in ammonia synthesis because nitrogen can react with active iron atoms on the surface to form an iron nitride. This nitride in turn is capable of reacting with hydrogen to produce ammonia and form again the catalytic iron. Another series of experiments has shown that water vapor, one of the substances known to have a poisoning effect on synthetic ammonia catalysts, reacts with the active surface iron atoms to form a catalytically inert oxide of iron. Nearly complete restoration of activity results when pure hydrogen is again passed over these materials. The most modern developments in the fields of physics and chemistry are being applied to the study of these various reactions.

The production and purification of hydrogen used in the manufacture of synthetic ammonia is also a catalytic process. The hydro-

gen produced by the passage of steam over hot coke (water-gas process) contains about 35 per cent carbon monoxide, a substance which is very poisonous for synthetic ammonia catalysts. The removal of this impurity is effected most economically by taking advantage of its reducing properties and causing it to unite with steam to form more hydrogen. Commercially this is accomplished by means of catalysts, but with those in general use at present the conversion is incomplete. During the past year new catalysts have been developed which operate at lower temperatures and give more complete conversion. This work has not only resulted in improved water-gas catalysts but has furnished some new and valuable fundamental data concerning the oxides of iron and cobalt and their reduction that will be of use in the commercial production of these metals.

HIGH-PRESSURE STUDIES

In the commercial production of ammonia the combination of nitrogen and hydrogen gases takes place at high pressures. Under such conditions the physical properties of the gases can not be estimated even approximately by the laws governing the behavior of gases at low pressures. Accordingly, in order to design high-pressure apparatus and completely to understand the chemical equilibria involved, the behavior of the gases alone and in mixtures must be studied in detail over a wide range of conditions of temperature and pressure. Repeated requests from the nitrogen industry for such information emphasizes the need for continuation of such studies. During recent years detailed studies have been made with the two gases concerned in ammonia synthesis, namely, hydrogen and nitrogen; more recently the work has been extended to include carbon monoxide and methane, both of which are of interest in connection with the production of hydrogen. The solubility of all four of these gases in water at 25° C. and at pressures up to 15,000 pounds per square inch is now being determined. The specific heats of these gases at high pressures can now be calculated from the data obtained. Much of the information is of direct value in many other industries where high gas pressures are used.

Special metals or alloys are required where corrosive gases or liquids are used, particularly if high pressures are involved. Tests of a number of different steels exposed for long periods of time to high temperatures and highly compressed hydrogen-nitrogen-ammonia mixtures have just been completed. A study has also been made of the corrosion of iron and numerous alloys by phosphoric acid of varying degrees of purity.

UREA PRODUCTION

Ammonia gas, the end product of the synthetic ammonia process, must be converted into nitrogenous compounds having chemical and physical properties best adapted for use as fertilizers. One of the possibilities being investigated is the production of urea, a highly concentrated nitrogenous fertilizer, from ammonia and carbon dioxide. These two gases, both products of the synthetic ammonia process, unite to form a solid compound, ammonium carbamate,

from which urea may be obtained by heating to a temperature of 150° C. in a closed vessel. A small-scale plant, constructed for the production of urea in this way, has been operated to obtain further information on the conditions favorable to urea formation. The data obtained have more completely defined the factors influencing the conversion of ammonium carbamate to urea and the means of controlling these factors in commercial operation. An exploration of the thermal conditions in the autoclave in which the conversion is carried out has indicated possible economies in operation through the conservation of heat; it has also furnished information on certain features of operation.

Because of the corrosive action on ordinary structural metals of the molten material in the urea autoclave, a new series of tests on 12 of the most promising metals was carried out under actual working conditions of temperature, pressure, and flow. The results show that ordinary metals are rapidly attacked under these conditions, but that a nickel-chromium steel of high nickel content is the most resistant of the materials tested. Much additional fundamental information on various phases of the process has been obtained and analytical difficulties overcome.

Although urea is a readily available fertilizer for plants it has the disadvantage of being rather hygroscopic, that is, it absorbs moisture from the air readily. Various efforts are being made to overcome this, particularly by combining it with other substances, such as formaldehyde. Attempts have also been made to obtain urea particles with a nonhygroscopic surface film, and partial success has been obtained. From the products obtained by reaction of aldehyde and urea, definite compounds are being isolated, and these, as well as the coated materials, are being tested as to the availability of their nitrogen for plant growth.

NITRATE PRODUCTION

Various nitrate fertilizers may be produced readily from synthetic ammonia. In the first step in this process oxygen is made to combine with ammonia by means of a catalyst, such as platinum, to form nitrogen oxides. The oxides can then be converted easily into various nitrates for direct use as fertilizers. The platinum catalyst performs a function in this reaction analagous to that performed by iron in ammonia synthesis. This platinum catalyst is likewise easily poisoned by certain impurities in the gases involved. Studies, conducted on the formation of the nitrogen oxides, as well as on the effect of certain poisons on the catalyst, are furnishing information of both scientific and industrial importance.

PHOTOCHEMISTRY OF NITROGEN

A constant search for entirely new methods of rendering nitrogen chemically active is being conducted. As a direct result of this research policy evidence has recently been obtained which indicates that light of a very short wave length will serve as an activator of nitrogen. This suggests numerous possibilities and at the same time may explain some of the facts already known. For instance, in the arc process for nitrogen fixation, now no longer used to any great

extent commercially, three main factors are at work, any one of which may cause nitrogen to combine with oxygen. These are electricity, heat, and light. Until recently an electrical or thermal mechanism seemed to have been rather generally assumed, but the results obtained in this bureau indicate that the photochemical effect of ultra-violet or very short wave lengths produced in the arc may also be an important factor. These studies are not, however, being conducted with the idea of developing an improved arc process; the purpose is more fundamental, namely, to get at the scientific explanation of how and under what conditions light can so radically modify gaseous nitrogen. In recent years spectroscopy has furnished detailed knowledge of the structure of the nitrogen molecule; we are now in position to try to alter this structure so as to render this exceedingly inert substance chemically active.

NITROGEN FIXATION BY LIVING ORGANISMS

The great bulk of the nitrogen used by crops is nitrogen previously fixed by living organisms. We have no way of estimating the yearly quantity of fixation through biological channels, but we do know that the total supply fixed commercially is but a small percentage of that constantly being fixed by natural agencies. The three types of nitrogen-fixing organisms, responsible for most of the fixation, are being studied. These consist of the free-living soil organisms, such as *Azotobacter*; the nodule bacteria which live on the roots of leguminous plants; and certain blue-green algae. The purpose of this work is to determine the mechanism by which these lower forms of plant life are able to utilize inert nitrogen gas. Such living organisms fix nitrogen at ordinary temperatures and pressures and require no appreciable energy other than for growth processes. If nature's apparently simple system were known, the information might be applied to the development of very simple commercial fixation methods. The possibilities are inviting, and an intensive study is being made.

Investigations on *Azotobacter*, conducted during the past year, have furnished considerable information that has a direct bearing on the chemistry of the fixation process. It has been determined that no appreciable quantity of energy is required for fixation; furthermore, that either the element calcium or strontium is essential. A very small concentration of a readily available nitrogenous compound is sufficient to prevent all fixation. The behavior of the organisms, particularly with respect to nitrogen fixation, was determined at varying pressures of nitrogen and other gases. Studies of the effect of the growth-stimulant humic acid, extracted from soil, were made to determine if there is a corresponding effect on the fixation process.

Recent researches on legume-nodule bacteria have concurred with earlier findings in showing that the organisms do not fix nitrogen when growing apart from the host. In recent experiments the bacteria were grown under a variety of pressures of nitrogen, hydrogen, and oxygen. Additional studies are in progress which are expected to furnish more information regarding the relations existing between these bacteria and their host. Conditions are also being worked out

for the growing of leguminous plants under sterile or pure culture conditions and using artificial illumination.

Cultures of blue-green algae, which can use free nitrogen, were isolated from soil during the past year. These are the only chlorophyll-containing plants definitely known to be able to fix nitrogen without the aid of bacteria. The organisms grow practically as well in the absence as in the presence of fixed nitrogen, using sunlight as the sole source of energy. We know that these organisms are found widely distributed in soils, fresh-water lakes, and streams. No doubt they are responsible for considerable fixation, but their economic importance can not be stated from our present limited knowledge. Optimum conditions for growth are being determined prior to the beginning of chemical studies relating to the mechanism of nitrogen fixation.

RELATION OF FREE NITROGEN TO ORGANIC COMPOUNDS

The large quantities of nitrogen fixed in nature annually are stored up in the cells of the nitrogen-fixing organisms almost wholly in organic forms, principally as proteins and amino acids. We do not know the first step in the fixation process, but very likely even this is organic in nature. The purpose of the research program is to attack this problem directly by cooperation with those working with the living nitrogen-fixing organisms, and by a study of certain organic compounds or materials which appear to possess peculiar properties with respect to nitrogen. The work is aimed eventually at a nitrogen-fixation method which corresponds more closely to nature's system.

Certain organic compounds, such as those containing the azo and diazo groups, are being closely studied, since the nitrogen in these is closely related to molecular nitrogen in that they readily split off free nitrogen, leaving the rest of the molecule intact. It is hoped by a study of the energy relations involved in such reactions to throw light on new mechanisms for nitrogen fixation.

Another phase of the work deals with chlorophyll, the plant substance responsible for the fixation of carbon in nature. The energy-containing materials, synthesized by means of the chlorophyll, using sunlight as a source of energy, are essential for biological nitrogen fixation. In the case of the nitrogen-fixing algae the question arises as to how closely the chlorophyll present plays a part in the fixation process. In the case of bacteria the rôle is necessarily an indirect one. The relationships between nitrogen fixation by organisms, their processes of photosynthesis, and utilization of energy are so interwoven that it becomes highly expedient to treat the subject as a whole in the research program. Fortunately, this laboratory is well equipped for such a comprehensive study. Any results obtained should be of direct interest to those working on various plant problems and in other branches of agriculture. During the past year most attention has been given to the preparation of pure chlorophyll; its properties and reactions will be studied later.

POTASH

Progress in the development of an American potash industry is encouraging, the current annual production of potash salts being more than 100,000 tons, with a value of \$3,000,000. Nevertheless,

we still spend about \$23,000,000 annually for imported salts, of which \$18,000,000 is for agricultural potash. The purpose of the research work being conducted in this bureau is to work out methods for the production of potash at low cost from our available potash-bearing minerals. Sufficient progress has been made to warrant confidence that national independence with respect to this fertilizer material is now within sight.

Several methods are now in use or being developed for potash manufacture, but these may for convenience be grouped under two general types, namely, wet extraction and furnace methods. In the wet extraction processes the potash is produced by crystallization of natural brines or by treatment of the mineral with such reagents as mineral acids, certain alkalies, and nitrogen oxides in the presence of water. The furnace methods differ radically from all others in that the potash salts are volatilized and recovered directly from the furnace gases.

WET EXTRACTION METHODS

At the request of the Bureau of Mines the possibilities of the ammonia-carbon-dioxide treatment of the Texas potash saline mineral, polyhalite, have been considered and the essential data established. The entire feasibility of this procedure for the convenient separation of the potash, as sulphate, from its associated compounds of calcium and magnesium is indicated. Ammonium sulphate, a standard nitrogenous fertilizer, is produced as a by-product, the sulphate radical being derived from the mineral. The geographical location of the Texas deposits imposes the condition that the potash produced be in as highly concentrated form as possible if the product is to be widely distributed over the agricultural area of the United States in competition with the foreign potash distributed from the various ports of entry.

Another potash-bearing mineral, alunite, which occurs in large deposits in southern Utah, is being studied. While this mineral represents an entirely logical raw material for potash and alumina manufacture because of its high content of these constituents and the relative ease with which they may be separated, heretofore the processes applied have failed to meet the economic requirements of competitive conditions. Contributory to this situation is the fact that the alumina, a by-product of importance if not essential to the success of the proposed manufacture, has not been obtained sufficiently pure to enable it to enter the preferred market. This has been due to the fact that certain impurities, particularly silica, naturally present in the potash-bearing mineral, accumulate in increased concentrations in the alumina. A process has been devised and tested with affirmative results whereby the silica is eliminated as fluosilicic acid. Further work in progress has as its objective the elimination of iron. Improvements in heat treatments are expected to yield more uniform products, reduce fuel costs, simplify plant equipment, and reduce losses. A further objective is the utilization of the lower-grade alunite, as well as the high-grade mineral to which past operations have been restricted, with a view to increasing the potash potentialities of that raw material.

Enormous deposits of another potash-bearing mineral, leucite (wyomingite), occur in Wyoming. Fortunately, large deposits of high-grade phosphate rock and various other raw materials useful in fertilizer manufacture, together with abundant and cheap fuels, occur near by. Various researches are in progress to develop chemical processes best suited to this unique industrial situation. The production of available potash from leucite by treatment with the oxides of nitrogen and the various industrial acids is being studied, particularly from the viewpoint of by-product recovery.

Other potash-bearing materials, such as the greensands of New Jersey and the shales of Georgia, are being subjected to lines of attack similar to those used for leucite. In the case of the acid-extraction of greensand, iron and aluminum salts and adsorptive silica (glaucosil) are obtained as valuable by-products.

FURNACE METHODS

Fundamental research on the furnace treatment of various minerals for the volatilization of potash from its ores by blast-furnace procedures is yielding promising results. Electrical precipitation is used in this method for the recovery of the potash salts present as finely divided particles in the furnace gases. Preliminary results indicate the entire practicability of the method, particularly so when the furnacing of the leucite is combined with that of phosphate rock to yield both phosphoric acid and potash. The combination of these two fertilizer essentials to form the highly concentrated fertilizer salt, potassium phosphate, is contemplated as a logical means of reducing distribution costs. These costs must be given serious consideration where the fertilizer resources are far removed from the fertilizer-using areas. The blast furnace offers itself as a useful nucleus around which to assemble other chemical activities, due to the large volume of surplus gas it generates. The technology of potash recovery by blast-furnace methods, once developed as a part of the problem of smelting potash silicates, should also be applicable to the recovery of potash now currently liberated and lost in the iron and cement industries.

PHOSPHATES

In American fertilizer practice phosphoric acid represents an item of expense almost as great as nitrogen. The annual cost to the farmer is probably nearly \$80,000,000. Fortunately this country has large deposits in Florida, Tennessee, Idaho, and a few other States. In the present mining methods usually only the better-grade materials are used, the remainder being discarded as waste. The primary aim of the phosphate-research program of this bureau is to work out methods for more economically converting these phosphate-bearing minerals into suitable available fertilizer materials with the conservation of important by-products. It is desired particularly to develop methods which will make practical the utilization of the low-grade phosphate rock.

A study of the complete chemical composition of the various grades and types of phosphate rock is being made. This information is necessary as a basis for work on methods of phosphoric acid

production and for the recovery of any impurities which appear to have commercial value. X-ray studies have shown that phosphate rock consists of complex calcium phosphate having the general structure of the crystalline apatites. Consideration is being given to the possibility that a part of the available phosphate in fertilizer reverts to such forms when placed in the soil. The relation of the various impurities of phosphate rock, such as carbonates, sulphates, and fluorine, to the chemical constitution of the natural rock is being investigated. This question has an important practical bearing on the concentration of crude phosphates by flotation processes which are coming into use, particularly in the Florida phosphate fields. Results have shown that fluorine is definitely combined as a part of the phosphate-bearing mineral. The composition and properties of the waste-pond phosphates of Florida have been given special consideration. Vegetation, as well as chemical tests, indicate that the availability of this material is only slightly greater than that of ground phosphate rock regardless of the finely divided condition in which it naturally occurs.

Furnace methods discussed above in connection with potash manufacture are being applied with minor variations to the production of phosphoric acid. Sufficient experimental results have already been obtained to indicate definitely that these methods will lower costs, allow the utilization of low-grade materials now discarded, and produce highly concentrated products. This will result in a considerable saving in bags, handling, and transportation. Results so far made public have attracted the attention of many chemical manufacturers, both in this and foreign countries.

Most of the phosphoric acid manufactured in this country is now produced by the sulphuric acid process. Possible improvements in this method have been given consideration. A study has been made of the chemical composition of crude and concentrated phosphoric acids made from Florida pebble and Tennessee brown-rock phosphates produced by acid treatment. The possibility of substituting dilute phosphoric acid for sulphuric acid in the production of phosphate fertilizers is being considered.

Among the important by-products of phosphate production are fluorine compounds, particularly the fluosilicates. These offer interesting possibilities as substitutes for arsenic compounds in the manufacture of insecticides. During the past year an investigation of the volatilization of fluorine during the manufacture of phosphoric acid by furnace methods was made. Results obtained thus far indicate that about 25 per cent is driven off, principally as silicon tetrafluoride. Such volatilization in this case is no greater than that occurring during the manufacture of superphosphate by the sulphuric acid process.

CONCENTRATED FERTILIZERS

The trend in fertilizer manufacture in recent years has been toward the production of more concentrated products. This has been brought about partly by the fact that more concentrated ingredients are available from the synthetic ammonia plants, by-product coke ovens, and the various phosphate and potash producing plants. There has also been a desire to eliminate a large percentage of the

cost of bags, handling, and transportation so as to increase the profit to the farmer per dollar spent. There has been a tendency not only for the production of materials having a high content of one of the three fertilizer elements, but also for the production of single salts having two or even three of these elements present. This bureau is taking a leading part in working out methods of production of these various concentrated fertilizer materials and is studying their chemical and physical properties, suitability for mixture with other materials, and the properties of the various promising mixtures. Special attention is being devoted to the problem of obtaining mixtures that are suitable for use in drills; also to the type of machinery best suited to uniform field distribution.

One of the problems of particular interest at this time is the production of ammoniated superphosphate. Ordinary superphosphate, produced by the sulphuric acid process, will absorb either aqueous or anhydrous ammonia to the extent of about 6 per cent. In actual practice, however, from 2 to 2.5 per cent is now generally considered the practical limit, since larger additions cause a reversion of the phosphate to less available forms; at least this is the case as indicated by the present official methods of analysis. Chemical and vegetation tests are being made to determine more accurately the maximum practical percentage of ammonia which may be added to superphosphate. Since anhydrous ammonia is the cheapest and most concentrated of the nitrogen products that it is customary to prepare, it is desirable to use as much of it in this manner as is practical. By combining anhydrous ammonia, superphosphate, and potassium salts a high-grade mixture can be prepared from the cheapest materials on the market.

In continuation of previous work on the preparation of potassium nitrate it has been discovered recently that this salt may be produced by the treatment of potassium chloride with the oxides of nitrogen. In previous work a saturated solution of potassium chloride was used with the resulting production of the undesirable by-products, hydrochloric acid and nitrosyl chloride. By the dry method only the latter by-product is formed. For a successful commercial procedure, however, it will be necessary to utilize the nitrosyl chloride or recover the nitrogen contained in it. The various possibilities are being considered. The cost of fertilizers to the farmer may be reduced either by lowering the purchase price or by improving the quality and methods of use so as to produce better results on the crop without proportionately increasing the cost. Most of the fertilizer research in the past, conducted in this bureau, has been devoted to lowering the cost of production. More recently, considerable attention has been given to the improvement of drilling qualities and methods of application. In cooperation with the Bureau of Public Roads, studies of various types of fertilizer distributors in relation to the physical properties of the fertilizers have been made. Field tests in cooperation with several other organizations have indicated that more efficient distributors, better methods of application, and proper drilling qualities of the fertilizer, may make their use at least 20 per cent more profitable to the farmer than at present.

COOPERATIVE ENTERPRISES

Aside from the main activities, already discussed, much work of a cooperative nature is being carried on, both within the department and with outside agencies. A special effort has been made to make available to all those interested the highly specialized methods and apparatus developed for the specific problems at hand. Particularly is this true with regard to the projects dealing with catalysis, high-pressure gas studies, X ray, spectroscopy, and other problems involving modern physics. The application of such specialized methods offers exceptional opportunities for rapid advances in many lines of agricultural research. For instance, during the past year the X ray has been successfully applied to the identification of silicate minerals present in the colloidal material of soils. Mention has already been made of the use of the same methods for the study of catalysts and identification of the minerals present in phosphate rock. Likewise, photochemical studies are being applied to furnish fundamental information on the molecular structure of various compounds.

The application of improved modern methods to biological problems is proving especially fruitful. The use of gas-analysis methods furnishes a quick and accurate means of studying the rate of growth and metabolism of bacteria, algæ, and other small plants. Much of the information obtained on the relation of oxygen and nitrogen gases to nitrogen-fixing bacteria, their energy requirements, and the various factors which affect fixation was obtained advantageously by such methods rather than by those more commonly used by biologists. Likewise, during the past year ultra-violet light was successfully used for obtaining cultures of algæ free from bacteria. Previous attempts to make the same separation by ordinary biological methods repeatedly met with failure. There is room for a broader application of the same ideas into many other lines of research.

Certain activities may be classed as almost entirely cooperative. The analytical laboratory performs an important function in connection with the various research projects by working out new methods and furnishing data on the composition of the intermediate and final fertilizer products. The engineering section is called upon to design special equipment for practically every line of research being conducted, and also furnishes information to various branches of the fertilizer industry. Considerable attention has been devoted to the design of high-pressure equipment, a field in which the available information is exceedingly meager. Many questions dealing with the economics of fertilizer production are answered for the public and the industries. In fact, the policy of the bureau is to make all types of information readily available to those who wish it, both through publications of various kinds and directly through letters and personal contacts.

**PUBLICATIONS OF THE BUREAU OF CHEMISTRY AND SOILS
ISSUED DURING THE YEAR JULY 1, 1929, TO JUNE 30, 1930**

TECHNICAL BULLETINS

- No. 128. The Alteration of Muscovites and Biotites in the Soil.
No. 141. The Spontaneous Combustion of Hay.
No. 162. Tests of various Aliphatic Compounds as Fumigants.
No. 163. Inheritance of Composition of Washington Navel Oranges of Various Strains Propagated as Bud Variants.
No. 169. Comparative Data on Wearing Quality and Other Properties of Vegetable-Tanned and of Chrome-Retanned Sole Leather.
No. 170. A Pipette Method of Mechanical Analysis of Soils Based on Improved Dispersion Procedure.
No. 178. Properties of Soils Which Influence Soil Erosion.
No. 182. Factors Affecting the Mechanical Application of Fertilizers to the Soil.

CIRCULARS

- No. 95. Subsoil an Important Factor in the Growth of Apple Trees in the Ozarks.
No. 98. The Wonderful Variety of Pomegranate.
No. 110. Specific Gravity and Baumé Gravity Tables for Turpentine.

JOURNAL OF AGRICULTURAL RESEARCH ARTICLES

- Can Nodule Bacteria of Leguminous Plants Fix Atmospheric Nitrogen in the Absence of the Host.
Effects of Various Fumigants on the Germination of Seeds.
The Chemical Composition of Colloidal Material Isolated from the Horizons of Various Soil Profiles.
The Properties of Arachin and Conarachin and the Proportionate Occurrence of these Proteins in the Peanut.

SOIL SURVEYS

- | | |
|-----------------------------------|---------------------------------|
| Butler County, Nebr. | Lac qui Parle County, Minn. |
| Adams County, Nebr. | Warren County, Iowa |
| Wichita County, Tex. | Wilson County, N. C. |
| Summers County, W. Va. | Hidalgo County, Tex. |
| Monroe County, Wis. | Moody County, S. Dak. |
| Pierce County, Wis. | Salinas Area, Calif. |
| Muskegon County, Mich. | Willacy County, Tex. |
| Chico Area, Calif. | Monroe County, W. Va. |
| Columbia County, N. Y. | Carroll County, Iowa. |
| Linn County, Oreg. | Hyde County, S. Dak. |
| Howard County, Iowa | Chickasaw County, Iowa. |
| Herkimer County, N. Y. | Oroville Area, Calif. |
| Soda Springs-Bancroft Area, Idaho | Calumet County, Wis. |
| Quitman County, Ga. | Nuckolls County, Nebr. |
| Bradley County, Ark. | Nash County, N. C. |
| Webster, County, Nebr. | Rockingham County, N. C. |
| Nevada County, Ark. | Essex County, Mass. |
| Alpena County, Mich. | Wayne County, Ga. |
| Roscommon County, Mich. | Kossuth County, Iowa. |
| King City Area, Calif. | Lake of the Woods County, Minn. |
| Northampton County, N. C. | Clayton County, Iowa. |
| Middlesex County, Mass. | Brown County, S. Dak. |
| Salem Area, N. J. | Nacogdoches County, Tex. |
| Cass County, N. Dak. | Wayne County, Ind. |

MISCELLANEOUS

Report of Conference on Spontaneous Heating and Ignition of Agricultural and Industrial Products. (Joint publication of the National Fire Protection Association, the United States Department of Commerce, and the United States Department of Agriculture. Published and printed by the Government Printing Office.)

YEARBOOK ARTICLES

Sweet Potatoes High in Food Value and Vitamin Content.
Cotton-Gin Fires Frequent; Chief Cause is Static Electricity.
Insecticidal Properties of Fluorine Open Wide Field for Investigation.
Hides and Skins Have Potential Value Often Lost by Mishandling.
Starches Imported for Some Uses, Though U. S. Has Surplus Cornstarch.
Mayonnaise Produced Commercially Since 1906 for Growing Trade.
Wheat That is Slightly Germinated Helps Flour When Sparingly Blended.
Nitrogen is Fixed in Nature Almost Wholly by Microorganisms.
Nitrogen's Functions in Plant Growth Make Cheap, Ample Supply Essential.
Gases Response to High Pressure and Temperature Shown.
Fertilizer's Value Measured in Tests in North Carolina.
Fertilizer Applications That Show Most Profit Are Difficult to Make.
Chlorophyll, Cause of Greenness in Plants, is Influenced by Nitrogen.
Potash Development in United States Requires By-product Utilization.
Light-Wave Lengths Yield Information Important to Farmer.
Soil Activities Affected in Complex Manner by Plowing in Green Manure.
Soil Color is Clue to Presence or Lack of Desirable Qualities.
Soils Under Various Conditions Hoard, Bank, or Waste Plant Food.
Fertilizer Materials for Cotton Growing Must be Well Chosen.
Soil's Acidity Can Be Accurately Measured by the pH Value.



REPORT OF THE CHIEF OF THE BUREAU OF DAIRY INDUSTRY

UNITED STATES DEPARTMENT OF AGRICULTURE,
BUREAU OF DAIRY INDUSTRY,
Washington, D. C., September 29, 1930.

SIR: I submit herewith a report of the work of the Bureau of Dairy Industry for the fiscal year ended June 30, 1930.

Respectfully,

O. E. REED, *Chief of Bureau.*

HON. ARTHUR M. HYDE,
Secretary of Agriculture.

During the year the research work of the bureau was expanded, and some changes in organization were made.

Plans were completed for carrying into effect a cooperative arrangement between the bureau and the Office of Cooperative Extension Work, for placing dairy subject-matter specialists in each of the four main geographic divisions of the country. Three of these specialists are actively at work in their respective divisions, the Northeastern States, the Central States, and the South. A fourth man, who will work in the Western States, will be appointed shortly. The results thus far from this extension work are very favorable.

Although the bureau is primarily a research organization, it is actively interested in having its findings applied promptly and effectively in the dairy industry. The new dairy extension specialists and the bureau's information office are doing effective work in getting information on new, better, and more profitable practices into the hands of the industry, and also of the general public. The bureau has increased its facilities for issuing information through publications, the press, radio, and exhibits. The great demand for dairy exhibits for fairs and expositions of various kinds is becoming increasingly heavy.

Raising the general level of quality of dairy products, more particularly of milk and cream, is one of the most important matters facing the dairy industry, and in this, of course, the entire public has a vital interest. The quality-improvement project of the bureau is one of the most important items of work for the bureau's dairy extension specialists, who, in cooperation with the extension services of the States, are giving a great deal of attention to this work, and considerable progress has already been made. To reach the goal of general high quality is largely a matter of getting before the dairy

farmers and others of the industry the facts and information regarding the practices which have been found through research and investigation to give the best results.

Perhaps the most important thing from the standpoint of research which confronts the dairy industry to-day, is that of getting more data and information concerning the production of the Nation's dairy cattle. The only reliable figures available, showing the actual production of any considerable number of dairy cows, are those obtained through the dairy herd-improvement associations, which are local cooperative organizations of dairy farmers and which employ herd-improvement agents, or testers, to assist them in keeping records on production and cost of production. In the past the dairy herd-improvement association work has been carried on more or less as a demonstrational or extension activity, but the bureau and leaders of the dairy industry believe the time has come when the work should be very materially expanded in order that more research work may be done on the efficiency and economy of production of dairy cattle.

It is estimated that the average yearly production per cow of the 22,500,000 milk cows in the United States is 4,600 pounds of milk containing 180 pounds of butterfat. In commercial dairying this production is not high enough to pay the costs of feed, labor, and overhead and still leave a profit.

The present low average production of the Nation's dairy cows is a serious economic handicap to consumers as well as to producers of dairy products. Because of the low production per cow, many dairy farmers are working for a very low wage and are actually feeding their cows at a loss. With fewer cows and a higher average production per cow the net profits of the average dairy farm could be greatly increased.

Although it is impossible to make provision for obtaining production and feed cost records on all the dairy cows in the United States, it is possible to get a sufficiently large number of reliable production records to furnish an accurate picture of the farm side of the dairy industry. A thorough study of these records would provide an index to methods of management which would enable the average dairyman to increase his profits. With a greater number of accurate records it would be possible to determine the true value of a large percentage of the bulls that head our dairy herds and evaluate their influence in bringing about herd improvement by increasing production per cow. This investigational work, now being conducted on a comparatively small scale, should be increased to the extent that meritorious proved bulls would be available for all the dairy herds on test and for many of the herds not on test. A comparison of accurate and complete yearly production records of the daughters of each sire with those of their dams would enable the great majority of dairy farmers to more rapidly and economically improve their herds of dairy cattle.

After 12 years of careful study of the problem of raising the production efficiency of dairy cattle through breeding, it is believed that the only sure way to establish a high and profitable level of production is through the use of "proved" bulls. By using in those herds which supply the seed stock for the great majority of dairy farmers only those sires which are definitely known to have the

hereditary ability to transmit high production to their daughters, it is possible to build up strains of cattle which will be practically pure for high production; and when this point is reached, all animals in these herds will be capable of high production by virtue of their inheritance, and bulls coming from these herds will transmit to their offspring those hereditary factors which make for high production.

The governments of other countries, particularly of those countries which are producing sufficient quantities of milk and dairy products to influence the world market, and which are now actually influencing the world market, long ago recognized the necessity for obtaining fundamental data on the production of their dairy cows as a basis for the improvement of dairy cattle on a national scale. These governments have given assistance to their dairy farmers through grants and appropriations. As early as 1895 Denmark began to make and study the records of her dairy cattle and is now getting records on 31.3 per cent of all her dairy cattle. The Netherlands gets records of 20 per cent of her cattle; Scotland, 16.8 per cent; Sweden, 11 per cent; Germany, 9.8 per cent; and England, 6.4 per cent. In the United States records are being secured on only 2.5 per cent of the dairy cattle. This percentage is entirely too small to allow the American dairy industry to make the progress that it should make.

In the course of the year the State of Tennessee transferred to the Federal Government, by deed, 485 acres of land for the use of the United States Dairy Experiment Station at Lewisburg, Tenn., and funds have been appropriated by Congress to provide for the establishment of the station. The bureau's research and experimental work there was begun during the year. Construction of the buildings is now well under way. A herd of Jersey cattle has been bought for the station, and the bureau has already begun its cattle-breeding work there. The research work will include not only the breeding of dairy cattle but also feeding and pasture investigations, with a view to getting information on the feeding and pasture problems peculiar to that large region in the central South in which the conditions are similar to those prevailing at the station. The State agricultural experiment station is cooperating in this work.

During the year the bureau received many requests from the industry, both farmers and manufacturing plants, for architectural and engineering assistance in the construction, arrangement, and equipping of dairy structures of various kinds, and assistance was given. In rendering this service the division of agricultural engineering of the Bureau of Public Roads cooperated.

RESEARCH LABORATORIES DIVISION

L. A. ROGERS, *in Charge*

MILK SECRETION AND THE NUTRITION OF DAIRY COWS

An extensive rat colony has been established in connection with the nutrition laboratory, and its value in work on milk secretion has been demonstrated. Some parts of the work for which rats are especially adapted could not be done with large animals. The rats are being used, among other things, to determine the amino acids essential to milk flow.

Glutathione, a nitrogen and sulphur holding compound occurring in the blood, has been studied in many laboratories and is interesting on account of its possible connection with the sulphur-holding amino acids of casein. The work of this division has shown that a large proportion of the glutathione of the blood is removed when it passes through the mammary gland.

The chemical structure of this compound, which has been the subject of considerable difference of opinion, was definitely determined by work done in these laboratories in the last year. This achievement will be of value in determining the part played by glutathione in the synthesis of casein in the udder.

MINERAL METABOLISM

Investigations on this subject are designed to study the tendency of cows to lose calcium from their bodies during lactation and to store calcium during pregnancy for lactation.

Some preliminary work has been done on the relation of the parathyroid gland to this function. An attempt also has been made to prevent the loss of calcium by supplementing the normal ration with calcium in the form in which it occurs in some of the best roughages.

There is a wide variation in the calcium content of timothy hay, and a corresponding difference in the efficiency of this hay in maintaining a cow's calcium balance. As no definite information is available on the conditions which determine the calcium content of a hay, some experimental plots have been seeded at the United States Dairy Experiment Station at Beltsville, Md., to study this question.

In the course of the experiments it has been observed that cows fed for a long period on a ration that is satisfactory according to all accepted standards, eventually show marked evidences of physiological disturbance. This is prevented or corrected by changes in the ration which would seem to correct a vitamin or mineral deficiency. This phenomenon will be studied further.

VITAMINS IN ROUGHAGE

Since there is a possibility that the physiological effects observed on feeding various roughages may be due, in part at least, to vitamins, work has been started to determine the amount of the several vitamins in different types of roughages. Preliminary work has been necessary to determine whether rats will consume enough hay to furnish the required amount of vitamin A. Check experiments, using an extract prepared to prevent the destruction of the vitamin, have indicated that the vitamin value of the hay could be determined by feeding the ground hay. The work has been confined to the vitamin A content of different grades of alfalfa and timothy hay.

Attempts to maintain rats on a ration suitable for a dairy cow have not been entirely successful and have indicated that the digestive system of the rat can not be adapted to the high-roughage content of the dairy ration.

CHEMISTRY AND BACTERIOLOGY OF MILK

In attempting to solve the problems in dairy manufacture relating to bacteria, the investigator is continually confronted with ques-

tions of a fundamental nature which are still unanswered. Sterilization of any food product without impairing the quality is difficult, because high temperatures and prolonged exposures are necessary to destroy bacterial spores. For this reason a complete knowledge of the conditions under which bacteria form spores, why and when they germinate, and the factors which determine the temperature at which they are destroyed, is of major importance.

Some progress has been made in determining the conditions which control the germination of spores. Among the factors studied are food supply, concentration of neutral salts, and osmotic pressure.

Some interesting and significant observations have been made on the germicidal action of milk. It is generally assumed that this property of milk is too weak and too transient to have any practical value. It has been found, however, that the milk of some cows has a decided retarding action on certain bacteria of the sweet-curdling type, and that this action may continue for many hours. This may explain the erratic development of bacteria in the milk that is taken to factories and the difficulty in duplicating bacterial effects under controlled conditions.

Certain types of bacteria occur persistently in the udder of healthy cows, but under normal conditions multiplication is restricted, presumably by the bacterial action, and high numbers are not attained.

Some of these are slow-growing micrococci, but others are streptococci which multiply rapidly in milk after it is drawn from the udder. When an udder, which normally contains at most a few hundred of these streptococci per cubic centimeter of milk, is removed at once after slaughter and held at blood heat, rapid multiplication of these bacteria in the milk in the udder begins at once.

This indicates that the bactericidal principle of milk is dependent on the circulation of the blood and is no longer present in the milk when the circulation is cut off.

In the ripening of cheese and in the manufacture of other dairy products involving the growth of bacteria, the action of one variety of bacteria on another is important, not only in determining the predominant flora but also in influencing the changes which they bring about.

It has been shown that in the ripening of Swiss cheese the nature of the eyes is influenced by the presence of bacteria which do not take part in the fermentation producing the gas. Bacteria of the *Streptococcus lactis* type grow rapidly, and unless they are greatly outnumbered at the start, they soon establish conditions typical of this species, regardless of the competing organisms.

CONDENSED MILK AND MILK POWDER

Although the subject has been quite extensively investigated, it has not yet been conclusively established what conditions in the milk determine the temperature at which it coagulates, either in its natural state or in the form of evaporated milk. A study of the composition of the milk of a number of cows covering an entire lactation period, which was completed in the last year, did not show any variation in any one constituent or combination of constituents which could be correlated with the heat stability.

In this connection determinations have been made of the size of the colloidal particles of calcium caseinate as they exist in milk.

Although the variation in the particle size was not great, the determinations indicate that there is a relation between particle size and heat stability.

In determining the mineral constituents of milk it was necessary to perfect a method for rapidly separating milk serum from the whole milk, and to devise a more correct method for determining citric acid. Results obtained by this method show that former results are too low.

In attempting to explain discrepancies in the determination of fat in skim milk and buttermilk, it has been stated that the errors were due to the inclusion in the fat of some of the phospholipids which occur in small quantities in milk. An accurate method for the determination of these substances has been used to show that although they cause an appreciable error in the Roesse-Gottlieb method they are not an influential factor in the Babcock test.

There is great opportunity for increasing the use of dairy products in cake making, but so little scientific work has been done on cake that it will be necessary to pave the way to practical results by much fundamental investigation and development of methods. Generally speaking, in the matter of quality the commercial bakery has not been able to compete with the housewife as successfully in cake making, as in bread making. The accumulation of information which will make it possible for the bakery to standardize the making of cake comparable in quality with that made in the home should result in additional outlets for dairy products. Both the fat and the solids not fat have a function in the control of color and production of flavor in cake. To prevent staling is very important, and dairy products may serve a useful purpose in this connection.

Some significant results have been obtained in the last year on the influence of hydrogen-ion concentration of milk on the color of cake. Strongly acid milk makes a much lighter chocolate cake than sweet milk, and the same relation holds for angel cake.

It has also been shown that even inferior butter gives cake a better flavor than some of the prepared shortenings. Apparently one of the reasons why butter is not used more extensively in bakery cake is because of the difficulty in getting a satisfactory emulsion. Work has been started on this problem, but it has been necessary to suspend it until a constant-temperature laboratory can be completed.

ICE CREAM

In the ice-cream investigations an attempt is being made to establish the significant physical properties of ice-cream mixes and to correlate these on the one side with the kind and treatment of the ingredients and on the other with the quality of the finished product. In doing this it is feasible at the same time to investigate the possibility of utilizing new dairy products, such as the whey proteins, and of modifying the properties of some of those now ordinarily used.

The results with the whey proteins are conflicting, but they show a distinct effect on the physical properties of the mix. Additional work is required to determine whether the whey proteins can be so prepared that they will have a beneficial effect on the finished product. Somewhat similar work has tended to show that by heating

the skim milk to a relatively high temperature before drying, the effect of the powder in ice cream is more pleasing to the consumer. There is also a very definite relation between the temperature at which the milk is heated and the physical properties of the mix.

CHEESE MANUFACTURE

In the last two years intensive studies have been made not only on the bacteria used as starters and occurring normally in Swiss cheese, but also on those that grow in the milk. Special attention has been given to the effect that these bacteria have on each other, and how they influence the quality of the cheese when they act together. A fancy Swiss cheese is the result of the combined action of several groups of bacteria, that function properly only when a very definite balance is maintained among them. The presence of undue numbers of some particular group may upset this balance and materially influence the quality of the cheese. A limited growth of certain types of bacteria in the milk may be beneficial or even essential for good quality of cheese, whereas too great a development of these bacteria may be very detrimental. This is true of bacteria which do not grow in the cheese at any stage of its ripening.

This work has shown also that bacteria that do grow in the cheese, but are themselves incapable of causing the fermentation to which the formation of the eyes is due, may by their action on the eye-forming bacteria, have a marked influence on the eyes. In some cases this action is distinctly beneficial, but some varieties have a detrimental effect.

New information has been obtained in regard to the rate of multiplication of the starter cultures at different temperatures, and the relation of the stage of growth at the time of inoculation into the milk to the quality of the cheese.

The production of a texture in the culture cheese comparable to that obtained in the best of the cheese made with the natural rennets continues to be the most serious problem of the Swiss-cheese work. A method has been devised by which significant differences in the texture of the 24-hour-old cheese can be detected and measured. Differences measured by this method are correlated with variations in the rate at which acidity is developed in the cheese during pressing.

These observations will be continued in an attempt to correlate them with bacteriological conditions in the young cheese and also with the texture of the ripened cheese.

Under laboratory conditions it has been found possible by controlling temperature to improve the defective texture near the rind indicated by poor eye formation and cracking. This method is simple, and there seems to be no reason why it could not be used in commercial factories.

An experiment in canning Cheddar cheese fresh from the press was a failure from a commercial standpoint, because the cans used were not suited to this purpose and there was a large percentage of loss due to leakage. However, it showed that with a satisfactory can losses due to shrinkage and rind can be eliminated and a very satisfactory and readily salable product obtained. No trouble was encountered from swelling of the cans.

BY-PRODUCTS

CASEIN

Economic conditions have made it advisable to resume the work on casein. On account of the demand during the World War for a high-grade casein for glue making, a process of manufacture was developed by the bureau which became known as the grain-curd method.

This grain-curd method, or modifications of it, has been used in some of the larger factories in making casein for paper coating. In the last year this method has been standardized for factory use, and the quality required in casein for paper coating determined. It was found that, when the temperature and hydrogen-ion concentration of the precipitation were controlled as prescribed by the method, proper washing could be obtained and the casein possessed the ready solubility, low viscosity, and high adhesiveness required for paper coating. By varying the reaction and the temperature, sulphuric acid may be used in place of hydrochloric acid. An indicator paper has been devised which is satisfactory for controlling the reaction in the factory.

An investigation has been made of the quality of casein made in creameries at the present time, and this shows that there is lack of uniformity and in some cases poor quality. Field men have been given instruction in casein making, and the process is now on a factory-introduction basis.

MILK SUGAR

Lactose, which makes up about one-third of the solids of milk, presents the greatest problem in the disposal of by-products. If a satisfactory commercial outlet for lactose could be found, casein could be made a really profitable product, and the price paid for milk for cheese making could be materially increased. For this reason special attention has been given to the manufacture of lactose and new ways of utilizing it.

This investigation has been directed along three lines: (1) Improvements in the methods of manufacture, with the object of reducing the cost and increasing the yield; (2) conversion of the alpha-hydrate, the sugar of commerce, to the beta-anhydride, which is sweeter and more soluble and therefore more suitable for table use; and (3) the fermentation of the lactose to products having a commercial value.

On the first part of the problem some distinct advances were made during the year. In the usual commercial process the proteins are removed by acidification and discarded before the sugar is crystallized. In the new process which has been developed the sugar is crystallized from concentrated whey, leaving the albumen in its natural condition for further purification.

Last year this process was still further improved by the addition of calcium salts to acid whey, or of some soluble phosphates to rennet whey. This has the effect of putting the concentrated whey into a better condition for the crystallization of the lactose. A more complete crystallization results, and as the crystals are larger it is easy to wash them, and the sugar obtained on the first crystal-

lization is sufficiently pure for all purposes except those requiring the highest purity.

The process of making beta-lactose has been sufficiently perfected to place it on a factory basis, but since no responsible commercial factory would undertake its manufacture under the present conditions, equipment has been installed in the commercial creamery at Grove City, Pa., where the bureau maintains laboratories under a cooperative arrangement with the creamery. Manufacture on a small scale will be started at Grove City at once. About 20 per cent of the lactose now made is consumed by adults for its therapeutic value, and it is evident that this consumption might be increased if a more palatable lactose were put on the market at a reasonable price. It seems very probable that the beta-lactose can be made at a cost not exceeding and probably somewhat less than that of the usual alpha sugar.

Some preliminary work has been started on the dietetic value of lactose in comparison with other sugars. The results already obtained are significant and warrant the amplification of this investigation.

Papers have been published discussing the physical and chemical characteristics of the different forms of milk sugar and methods of recovering them.

An investigation of the relative hygroscopicity of lactose and three other common sugars has been completed and the results published.

The rates of crystallization of lactose, galactose, glucose, and sucrose, at temperatures from -5° to $+30^{\circ}$ C. have been determined.

In past years various attempts have been made to convert lactose into marketable products by fermentation. A method of making citric acid by fermentation with molds has been applied on a large scale, but sucrose is used rather than lactose. A bacterial fermentation converting lactose into propionic acid was shown to be a commercial possibility, but on account of the limited demand for this acid the process has not been used. Lactic acid is produced from lactose by many types of bacteria, and the lactic fermentation of whey has been attempted commercially. The ordinary cheese or casein factory using the standard method for making lactic acid would have difficulty in competing with plants fermenting sugar wastes on a very large scale.

In some investigations on the lactic fermentation it has been found that by supplying fresh fermentable material the lactic fermentation can be carried on continuously and at a rate four or five times as fast as by the usual intermittent method. In laboratory experiments a 30-gallon vat of whey inoculated with an active *bulgaricus* culture required four days to ferment all of the sugar. However, beginning when the fermentation in the vat was complete, 30 gallons of whey was run through the vat every 24 hours with practically complete conversion of the lactose to lactic acid. About 80 per cent yield of lactic acid was obtained. By controlling the temperature and reaction it is possible to maintain a pure fermentation without sterilization.

This fermentation has been carried out on a small commercial scale in the creamery at Grove City, and a good grade of crude calcium lactate obtained. About 5 pounds of the lactate is produced per 100 pounds of whey.

WHEY ALBUMEN

The process of separating the albumen from whey without injuring its natural emulsifying or whipping properties has been perfected, but no satisfactory outlet has yet been obtained. Experiments are now under way to determine whether it can be used to advantage in ice cream. The whip results more quickly when whey powder is used, but it is not yet certainly known whether or not this may be offset by undesirable effects on the flavor and texture.

One possible and somewhat obvious way of utilization would be in modified milk to make the albumen content comparable with that of human milk. In the form in which it is separated whey albumen is not suitable for this purpose, because it contains the concentrated salts, and the addition of sufficient powder to make the albumen normal gives an abnormal ash content.

This difficulty has been overcome by the development of an electric dialyzer with which the salt content can be reduced 88 per cent in six to eight hours without loss or change in the albumen. This apparatus has earthenware cells instead of the usual delicate membranes, and it can be constructed on a large enough scale to make it practicable for commercial use. It promises to be a valuable addition to laboratory apparatus.

The albumen obtained after removing the greater part of the salts has, when added to milk, the effect of changing the nature of the curd produced by acid or rennet. Instead of being a tough mass, the curd is granular, resembling that found in human or goat's milk.

CULTURED BUTTERMILK

It was hoped that sufficient work could be done on this project to prepare a manual of buttermilk making based on scientific information, but the press of other work has prevented this. It has been determined that a greater viscosity and a consequent better stability results when milk is heated at a relatively high temperature, but that this is due to concentration of solids caused by evaporation. Similar effects are obtained by using Jersey milk in place of Holstein, or by adding milk solids. Milk sugar improves the flavor but does not affect the viscosity or stability. The texture and stability may be improved by adding skim-milk powder, but care must be exercised in the selection of the powder or the flavor will be affected unfavorably.

DIVISION OF BREEDING, FEEDING, AND MANAGEMENT
INVESTIGATIONS

R. R. GRAVES, *in Charge*

THE BREEDING HERD AT THE UNITED STATES DAIRY EXPERIMENT STATION AT
BELTSVILLE, MD.PROGRESS OF LINEBREEDING-OUTBREEDING PROJECT WITH HOLSTEIN-FRIESIAN
CATTLE

During the year one mature daughter of Denton Colantha Sir Rag Apple, the first proved outbred bull used in this project at the Beltsville station, was slaughtered for failure to breed, which left 29 of his daughters still in the herd. Of the original 37 Denton daughters,

28 have now completed first-calf official milk and butterfat records, 5 others are now undergoing test, and 1 more will start on test late in the fall. These 28 completed records averaged 14,524 pounds of milk and 500 pounds of butterfat for the year. The cows averaged 2 years 5 months of age at the beginning of the tests. Ten of the daughters of this bull have completed yearly records in mature form. These 10 records average 18,638 pounds of milk and 665 pounds of butterfat, at 5 years 9 months. Denton Colantha Sir Rag Apple now has 59 yearly record daughters.

Of the 37 daughters of Denton, 5 died without female offspring, 1 that is dead has 2 second-generation daughters, and the other 2 deceased have 1 second-generation daughter each. Six of the 29 living daughters have both outbred and line bred second-generation daughters, 12 have second-generation outbred daughters, and 11 have no female progeny. Only 1 of the 29 is known to be a nonbreeder.

Varsity Derby Matador is the second proved outbred bull used in this project, and he is being mated to the daughters of Denton to produce the second outbred generation. Seven heifer calves were dropped to his service during the year. One calf died, and one older daughter, a freemartin, was slaughtered, bringing the total of his living second generation outbred daughters to 26. All of these 26 are out of daughters of Denton Colantha Sir Rag Apple, the first sire used. His oldest daughter in the Beltsville herd, Lady Gerben Colantha Ona, completed a record of 21,891 pounds of milk and 752 pounds of butterfat, and gained the distinction of making the highest senior 2-year-old record for milk and butterfat in class B for the Holstein breed. Another of his daughters in this herd completed a record which ranks second for milk, and sixth for fat, in the junior 2-year-old division of class B.

Pride of the Bess Burkes was the third proved outbred sire used in this project. He died in April as a result of an unavoidable accident. He was being mated to the daughters of Varsity Derby Matador to produce the third outbred generation. Six heifer calves sired by Pride were born during the year, bringing his total to nine, with three cows still to calve. It is unfortunate that this bull left such a small group of daughters. Another proved bull, one not related to him, will be obtained to carry on the outbreeding phase of this experiment.

The first generation of line-bred females now numbers six, of which three were added during the year. They are sired by Sir Gerben Colantha Rube (a son of Varsity Derby Matador and out of a daughter of Denton Colantha Sir Rag Apple). The dams of these line bred females are also daughters of Denton. The relationship of their sire and dams is that of nephew and aunt. Eight other Denton daughters are pregnant to the service of Rube.

The second line-bred generation will be started in the near future, when Pride Ormsby Gerben Colantha Ona (a son of Pride of the Bess Burkes from a daughter of Varsity Derby Matador) is mated to the daughters of Varsity Derby Matador. This also is a nephew-to-aunt mating.

There were 62 females in the Holstein-breeding herd at Beltsville at the beginning of the year. Among 49 females of breeding age, 43 pregnancies resulted in 20 female calves, 18 male calves, and 5 abortions. Of the 20 heifer calves, 2 were born dead and 2 died after

birth. One mature cow and 1 freemartin heifer were slaughtered, which leaves a net increase of 14 and brings the total number of females to 76. Twenty-five of these are over 5 years old.

PROGRESS OF INBREEDING-OUTBREEDING PROJECT WITH JERSEY CATTLE

Two of the sires in this project previously reported as sterile were replaced by sires of similar breeding.

There were three groups of foundation cows when the project started. Ten of these cows are still in the herd. One of the three groups was bred to the Moose O'Fernwood, an Owl-Interest-bred bull. At present there are 13 outbred and 2 inbred daughters of Moose still alive. Thirteen of his daughters have completed first-calf records which average 8,879 pounds of milk and 481 pounds of butterfat. Their age average is 2 years 7 months.

Inbreeding in this group was carried on by mating daughters of the Moose bull to one of his 75 per cent inbred sons. Five females of this combination are in the herd.

Oxford May's Interested Owl, another proved Owl Interest bull, followed the Moose O'Fernwood, and is being mated to foundation cows and to daughters of the Moose for outbred and line-bred groups. Daughters of other unrelated bulls are also being bred to him to produce an outbred generation to compare with inbred daughters of these bulls. Oxford now has 2 outbred and 3 line-bred daughters, and 19 cows are pregnant to his service.

Oxford May's Interested Owl has just qualified for the American Jersey Cattle Club's gold medal: and his first 12 daughters on register-of-merit test all qualified for silver medals, and 3 of them also earned gold medals of the breed on their production performance.

The cows of the second group of foundation cows were originally mated to Hood's Sophie's Tormentor, a Sophie-Tormentor-bred bull. He left only four daughters in the herd and was followed by Sophie's Torono 23d, a bull of the same family. This bull became sterile and was killed. There are 11 outbred daughters, 5 line-bred daughters out of daughters of Hood's Sophie's Tormentor, and five 75 per cent inbred daughters in the herd. Ten of his daughters have completed official records which average 9,769 pounds of milk and 515 pounds of butterfat, at the average age of 2 years 7 months.

The sire to succeed Sophies' Torono 23d is Sophie's Phoenix, another bull of the Sophie Tormentor family.

The sires used on the third and last group in this project all come from the Raleigh family of Jerseys. The first of these was Karnak's Noble 4th, which left 10 daughters in the herd, 7 of which are alive. The 10 have first-calf records averaging 8,500 pounds of milk and 470 pounds of butterfat, at the average age of 2 years and 4 months. Five have completed mature records, which average 11,292 pounds of milk and 652 pounds of butterfat. He was succeeded by Tiddledy-wink's Raleigh, a medal-of-merit bull. The herd contains 11 of his daughters, 1 being 75 per cent inbred. Five of these have completed first-calf records, which average 9,120 pounds of milk and 522 pounds of butterfat, at the average age of 2 years 3 months.

The third bull in service in this group is Raleigh's Dorothy's Senator, an inbred Raleigh bull, and 10 cows are pregnant to his service.

PROGRESS OF FAMILY CROSSING EXPERIMENT

Only one foundation female of the original stock used in this project remains in the herd. The number of animals has been limited, but all 2-family combinations now are represented by both males and females. At present there are 6 females and 12 males of various 2-family combinations. Fourteen females and 12 males are descended from 4 distinct families; 5 females and 3 males are of 6-family make-up and 2 females have a combination of ancestry from 8 separate families.

At the beginning of the year there were 103 females in the Jersey breeding herd. After that date 9 died or were slaughtered, and 27 heifer calves were born, 1 being born dead and 7 others dying after birth. The herd now totals 113. Exclusive of nonbreeders, 77 females of calving age had 65 pregnancies, which terminated with 55 calves (3 born dead) and 11 abortions. There are now 47 females pregnant out of a total of 92 of breeding age.

OFFICIAL TESTING AND PHOTOGRAPHY

The official tests which are made on all females to determine their milk and butterfat producing ability are conducted under uniform conditions from year to year in order to get comparable information on all animals. The same feeds are used, and the basis of feeding and management is standardized. These records are made on heifers after first calving and again when the animals reach maturity. As this work progresses valuable data are accumulating for later use in studying the influence of age and development upon production.

Two mature Holstein cows and six 2-year-old Holstein heifers completed official records during the year. The two cows averaged 18,386 pounds of milk and 651 pounds of butterfat, and the six heifers averaged 15,915 pounds of milk and 544 pounds of butterfat in 365 days. When these are included with records previously made, the summary shows that 69 Holsteins have completed 102 records, with an average of 16,491 pounds of milk and 569 pounds of butterfat, at the average age of 3 years 11 months.

Five mature Jersey cows finished official records averaging 12,926 pounds of milk and 703 pounds of butterfat, and eight 2-year-old heifers averaged 9,078 pounds of milk and 477 pounds of butterfat. These 13 records average 10,558 pounds of milk and 564 pounds of butterfat. When added to the previous official Jersey records the total is 118 records completed by 89 cows, averaging 9,912 pounds of milk and 541 pounds of butterfat at the average age of 3 years 9 months.

TABLE 1.—Average monthly milk and butterfat production for the entire Beltsville breeding herd for the last fiscal year

Month	Cows in milk	Milk	Butterfat	Month	Cows in milk	Milk	Butterfat
	<i>Number</i>	<i>Pounds</i>	<i>Pounds</i>		<i>Number</i>	<i>Pounds</i>	<i>Pounds</i>
July.....	96	718	29.2	January.....	115	869	39.8
August.....	101	691	28.9	February.....	119	822	36.1
September.....	99	691	29.6	March.....	125	934	40.7
October.....	97	759	33.9	April.....	121	917	40.8
November.....	103	794	36.2	May.....	124	922	37.8
December.....	112	847	38.2	June.....	129	816	33.7

Three hundred and twenty-four pictures of animals in the herd were taken, in accordance with the regular schedule for photographing the animals at certain ages.

PROVING BULLS

Thirty more dairy farmers were added to the list of cooperators who are proving out bulls of the Beltsville herd. These bulls are placed with dairy farmers in territory adjacent to the Beltsville station. These farmers agree to raise all daughters sired by bulls of the Beltsville herd and to keep the breeding and production records which are necessary for proving the transmitting ability of the bulls.

Fifteen young Holstein-Friesian bulls were placed with cooperators during the year, making a total of 60 bulls of this breed which are being proved. Seven others under 1 year of age are promised to cooperating farmers. Four of the 60 are in college herds.

Eighteen young Jersey bulls were placed with cooperators, bringing the total to 52, 6 of which are on loan to colleges. Four Jersey bulls under a year old are promised to cooperators.

The total of bulls from the Beltsville station now in service or definitely engaged is 123, a net increase of 11 over last year. Twenty-two are over 6 years old. Sixteen bulls were exchanged and seven were placed with new cooperators to avoid inbreeding. Arrangements with 12 cooperators were discontinued. The work is now being carried on in 10 counties in Maryland and 8 counties in Virginia, and satisfactory cooperation is being had from extension workers, county agents, and herd-improvement agents in these counties.

The Holstein bulls which were in service during the year now have a total of 839 daughters, with 173 in milk. The daughters of Jersey bulls in service now number 451, with 95 in milk. All information regarding production and breeding records on these daughters and their dams, as well as on all other cows in cooperators' herds, is being tabulated and filed for use in determining the transmitting ability of these bulls.

HEALTH AND FERTILITY STUDIES IN THE BELTSVILLE HERD

During the year two females in the abortion-free herd became positive to the agglutination test for abortion disease, and were added to the abortion-infected herd. Since May, 1926, when most of the abortion-infected animals were moved to new quarters, 45 animals have been taken from the abortion-free herd because their serum had changed from negative to positive when the agglutination test for abortion disease was applied. Nineteen of these have changed since October, 1926, when a complete separation of the cattle was made. The abortion-infected herd now consists of 68 females, all of breeding age. The abortion-free herd consists of 190 females, 139 being of breeding age. Table 2 shows the numbers of cattle in the two herds as to breed and age.

TABLE 2.—Number of cows and calves in the abortion-free and abortion-infected herds, by breeds

Breed	Number of females in abortion-free herd		Number of females in infected herd	Total
	Of breeding age	Calves		
Grade.....	34	11	11	56
Holstein.....	44	18	14	76
Jersey.....	61	22	43	126
Total.....	139	51	68	258

Testing for abortion disease was done every 60 days during the year. All animals in the abortion-free herd reacted negatively to these tests except the two that reacted positively on the first test of the year. The bacteriological and pathological work in connection with abortion disease is being done by the Bureau of Animal Industry.

BREEDING EFFICIENCY

The breeding efficiency of the animals in the abortion-free and in the abortion-infected herds may be shown in two ways, (1) by the percentage of animals of breeding age that become pregnant during the year, and (2) by the percentage of animals actually bred which became pregnant during the year.

If calculations are made by the second method in the abortion-free herd, 109 pregnancies occurred in the 137 animals actually bred, an average breeding efficiency of 79.56 per cent. In the abortion-infected herd 63 pregnancies occurred in the herd of 76 animals actually bred, an average breeding efficiency of 82.89 per cent.

Table 3 gives figures on breeding efficiency in detail for the animals in the abortion-free and in the abortion-infected herds that were actually bred during the year.

TABLE 3.—Breeding efficiency of the abortion-free and the abortion-infected herds
ABORTION-FREE HERD

Breed	Females in herd	Services		Concep- tions	Services per concep- tion	Effici- ency
		Total	Per fe- male			
Grade:	<i>Number</i>	<i>Number</i>	<i>Number</i>	<i>Number</i>	<i>Number</i>	<i>Per cent</i>
Cows.....	19	29	1.52	16	1.81	84.21
Heifers.....	14	27	1.92	13	2.07	92.85
Holstein:						
Cows.....	30	62	2.06	24	2.58	80.00
Heifers.....	19	59	3.10	15	3.93	78.94
Jersey:						
Cows.....	34	79	2.32	24	3.29	70.58
Heifers.....	21	56	2.66	17	3.29	80.95
Total.....	137	312		109		
Average.....			2.27		2.86	79.56

ABORTION-INFECTED HERD

Grade.....	11	23	2.09	8	2.87	72.72
Holstein.....	15	40	2.66	12	3.33	80.00
Jersey.....	50	148	2.96	43	3.44	86.00
Total.....	76	211		63		
Average.....			2.77		3.34	82.89

In this report all female animals 15 months old or older, which have not had calves, are designated as heifers. The breeding efficiency of the heifers and cows are given separately and are figured by the second method. Of the 54 heifers bred in the abortion-free herd, 45 conceptions occurred, an average breeding efficiency of 83.33 per cent. With the 83 cows bred in the abortion-free herd 64 conceptions occurred, an average breeding efficiency of 77.10 per cent. In the year the average breeding efficiency of the heifers was greater than the average breeding efficiency of the cows. The breeding efficiency of the Holstein heifers was lower than that of the Holstein cows, and the breeding efficiency of the grade and Jersey heifers was higher than the cows of their respective breeds.

STERILITY

In the abortion-free herd two animals were disposed of because they were considered permanently sterile. In the infected herd six animals were disposed of for the same reason. Permanent sterility is responsible for the loss of six animals in the abortion-free herd and 25 in the infected herd since the segregation of the infected animals. The percentage of females in the abortion-free herd that required more than three services per conception (temporary sterility, slow breeders) last year is less than in the infected herd. The percentage of cows in the abortion-free herd that required more than three services per conception during the year is considerably less than that of the infected herd. The percentage of heifers that required more than three services per conception is greater than that of the cows. Table 4 shows the distribution of temporary sterility among the several breeds. The females that were bred during the year are indicated in this table.

TABLE 4.—*Distribution among the several breeds, of temporary sterility, in the abortion-free and the abortion-infected herds*

ABORTION-FREE HERD					
Breed	Females	Females that re- quired more than three services per conception		Females not preg- nant at close of year that had more than three services	
		Number	Per cent	Number	Per cent
Cows:					
Grade.....	19	0	0	0	0
Holstein.....	30	2	6.66	2	6.66
Jersey.....	34	1	2.94	4	11.76
Total.....	83	3		6	
Average.....			3.61		7.22
Heifers:					
Grade.....	14	3	21.42	0	0
Holstein.....	19	5	26.31	3	15.78
Jersey.....	21	2	9.52	1	4.76
Total.....	54	10		4	
Average.....			18.51		7.40
All females:					
Total.....	137	13		10	
Average.....			9.48		7.29

TABLE 4.—*Distribution among the several breeds, of temporary sterility, in the abortion-free and the abortion-infected herds—Continued*

ABORTION-INFECTED HERD

Breed	Females	Females that re- quired more than three services per conception		Females not preg- nant at close of year that had more than three services	
		Number	Per cent	Number	Per cent
Cows:					
Grade.....	11	1	9.09	1	9.09
Holstein.....	15	2	13.33	2	13.33
Jersey.....	50	8	16.00	4	8.00
Total.....	76	11		7	
Average.....			14.47		9.21

As a means of relieving temporary sterility in those cases where no pathological conditions could be found, sprouted oats have been fed at the rate of from 2.5 to 5 pounds of dry oats per day. One cow and one heifer were helped thus during the year. The number of services for the cow before feeding sprouted oats was four, and after feeding, three. For the heifer, it was five before feeding sprouted oats and one after feeding. One cow and 12 heifers were fed sprouted oats before breeding began. They were fed an average of 103.3 days before conceiving. Three cows that had been bred an average of four and three-tenths times were fed sprouted oats, but it was found upon examination that these animals had conceived, on an average, 14.3 days before the feeding began. One cow affected with metritis and an abscess involving the genital organs was fed sprouted oats but remained sterile. No benefit was noted from feeding sprouted oats to eight apparently normal cows and to five apparently normal heifers that were bred four or more times per conception after feeding began. The feeding of sprouted oats is being continued.

Exercise as a means of strengthening the genital organs of cows which lack muscular tone was carried on in the abortion-infected herd again during the year. This is accomplished by driving the cows on a track for approximately two hours per day. Two of the twelve cows exercised became pregnant during the exercise period and two following it; four were pregnant when exercised, and four have remained barren.

The study of cows that do not come in estrum for long periods has been continued. Thirteen cows became pregnant on the first service following the removal of persistent corpora lutea, 2 conceived on the second service, and 5 conceived later, and 5 remain open. The practical value of removing persistent corpora lutea has been demonstrated.

CALVING EFFICIENCY

The calving efficiency of the two herds is shown by the percentage of living calves. Of the 148 pregnancies that terminated during the year, 87 were in the abortion-free herd and 61 in the infected herd.

The 87 pregnancies in the abortion-free herd resulted in 74 living calves, or 85.05 per cent; 8 abortions, or 9.19 per cent; and 5 calves, or 5.74 per cent, were born dead. The 61 pregnancies in the infected herd resulted in 47 living calves, or 77.04 per cent; 13 abortions, or 21.31 per cent; and 1 calf, or 1.63 per cent, was born dead. In addition to these pregnancies six cows were found pregnant on autopsy. No reason for the death of the calf born dead in the infected herd could be found. Of the 5 calves born dead in the abortion-free herd, 2 were mutilated in delivery, 1 was small and deformed, 1 was from a cow that died several days later of a general pus infection due to a foreign body, and no cause could be found for the other. Table 5 shows the termination of pregnancies for the several breeds.

TABLE 5.—*Termination of pregnancies of the several breeds in the abortion-free and the abortion-infected herds*

ABORTION-FREE HERD						
Breed	Live calves		Abortions		Dead calves	
	Number	Per cent	Number	Per cent	Number	Per cent
Grade.....	18	90.00	1	5.00	1	5.00
Holstein.....	29	87.87	2	6.06	2	6.06
Jersey.....	27	79.41	5	14.70	2	5.88
Total.....	74		8		5	
Average per cent.....		85.05		9.19		5.74

ABORTION-INFECTED HERD						
Grade.....	10	90.90	1	9.09	0	
Holstein.....	8	66.66	4	33.33	0	
Jersey.....	29	76.31	8	21.05	1	2.63
Total.....	47		13		1	
Average per cent.....		77.04		21.31		1.63
Total for both herds.....	121		21		5	
Average for both herds.....		81.75		14.12		4.05

Two of the eight abortions in the abortion-free herd were twins. *Bacillus coli* was isolated from one set of twins. Streptococci were isolated from one fetus. Laboratory work did not reveal the presence of any infection in the other five.

METHOD OF STUDYING BREEDING HEALTH OF COWS

All animals are examined after calving and again before breeding to determine whether any condition exists which might prevent conception. Also, they are examined for pregnancy 60 days after service. Treatment of abnormal conditions found follows immediately. A total of 234 animals were examined 634 times.

The abnormal conditions of the genital organs found in the animals of the abortion-free and infected herds are shown in Table 6.

TABLE 6.—*Distribution of genital abnormalities in the abortion-free and the abortion-infected herds*

ABORTION-FREE HERD

Breed	Corpus luteum interfering with estrum	Ovarian cysts	Inflammation of uterus	Inflammation of cervix	Unknown
Grade.....	8	0	0	0	0
Holstein.....	5	1	0	0	0
Jersey.....	8	1	0	0	3
Total.....	21	2	0	0	3

INFECTED HERD

Grade.....	1	1	0	2	0
Holstein.....	1	1	0	0	0
Jersey.....	5	1	1	1	4
Total.....	7	3	1	3	4

The cases listed under the heading "unknown" are of recent origin. These animals were found to be pregnant, and in from 60 to 100 days ceased to be pregnant. These cows were all bred to the same bull. So far the cause of this trouble has not been ascertained. One cow that died as a result of a foreign body had in her uterus a yellowish granular substance in watery suspension and a fetus that crumbled when handled. At first this was thought to be due to the general infection throughout this animal's body. Since then two other cows have shown similar material suspended in a mucous discharge. The following tabulation shows the causes of death of cattle in the herd at the Beltsville station.

Cause of death:	Number of deaths
Actinomycosis.....	2
Digestive disturbances.....	13
Injuries.....	4
Lung troubles.....	18
Septicemia.....	1
Not determined.....	3
Killed for anatomical studies.....	20
Total.....	61

Four of the digestive troubles were due to foreign bodies, and one of the cases of actinomycosis was so complicated by a foreign body as to cause one to believe that the foreign body caused death. Seven of the digestive troubles were in calves. Two calves died with twisted abomasums, one from consuming milk too fast, one was being fed gruel experimentally, and the other three were affected with gastroenteritis, or so-called scours.

All of the deaths from lung trouble were in calves. Twelve of these cases resulted from exposure to sudden changes of temperature during a severe winter storm. Three deaths were from navel infection. The contributing cause of the other three could not be ascertained.

RELATION OF THE CONFORMATION AND ANATOMY OF THE DAIRY COW TO HER MILK AND BUTTERFAT PRODUCING CAPACITY

ANTE-MORTEM AND POST-MORTEM STUDIES

The study of the relation between external form and internal anatomy, and between both external form and internal anatomy and producing capacity, has been continued. This work, which involves the measurement of conformation, and the slaughter and anatomical study of cows of known producing capacity, is carried on at Beltsville, and cooperatively at 19 of the State experiment stations. South Dakota State College and the University of Nebraska have been added to the list of cooperators. The work has been introduced at Michigan State College, South Dakota State College, and the University of Nebraska. The Oklahoma Agricultural and Mechanical College has been visited for the purpose of coordinating the work and assisting in the conduct of it. In addition, the distribution of descriptive and illustrative material and apparatus to cooperators has assisted materially in coordinating the work. Ante-mortem and post-mortem reports on 61 cows having production records were obtained during the year. Of this number, 13 were prepared at Clemson College, S. C.; 12 at the Beltsville station; 8 at Cornell University; 7 at Pennsylvania State College; 6 at Michigan State College; 6 at the University of Nebraska; 3 at the University of Florida; 3 at South Dakota State College; 2 at Utah State College; and 1 at New York State (Geneva) Experiment Station. The total number of such ante-mortem and post-mortem reports now on file is 292. Eighty-two of these have been submitted by the Beltsville station, 73 by Pennsylvania State College, 48 by Cornell University, 22 by Clemson College, 12 by the University of Missouri, 7 by the University of Florida, 6 by Michigan State College, 6 by the University of Nebraska, and 5 or fewer from each of 11 other cooperating stations. In addition to the cows slaughtered at Beltsville, anatomical studies were made with six bulls and three freemartins during the year. The post-mortem data on bulls are of value in connection with the study of normal growth and internal anatomy. Those on the freemartins (which are females twinned with males) are particularly interesting, in that they reveal a marked intersexual condition.

THE MAMMARY GLAND

The plan of recording the individual variations in external and internal udder development from birth to maturity, and in condition of udder during the productive life of the cow, has been continued. Frequent periodic examinations of the udder are made from birth to 18 months of age, and during the first lactation period and at least one other lactation period after maturity. Photographs of udder development of heifers at 18 months of age, and of cows in the third month of the first, and one other lactation period after maturity, are regularly taken. In addition, the relative size, type, and placement of rudimentary teats are recorded on bulls at regular intervals from birth to 1 year of age. During the year 282 examinations of udders of growing heifers, 567 examinations of lactating udders, 49 photographs of udders at 18 months, 63 sets of photographs of lactating udders, and 199 examinations of the rudimentaries of growing bulls were made.

Not only is the udder studied throughout the life of the animal, but some of the most valuable data are obtained after death. The regular procedure is to amputate the udder of the cow immediately after death, fill it with fluid, freeze it, and cut it into sections which are photographed to make a permanent record of gross anatomy. The microscopic structure of each udder is recorded also. The post-mortem studies of the udder therefore permit a study of the gross and microscopic structure of the organ, and the capacity of its secretory system and other characteristics, not only in relation to each other but in relation to the history of its development and its activity during the productive life of the cow. A total of 20 udders of dairy animals were sectioned during the year. Of the 20 udders thus sectioned, 5 were from calves ranging from 15 days to 2 months 20 days of age, 3 were from freemartins, and 12 were from cows. Since the beginning of this work, 79 udders, representing different breeds, different ages, and different stages of lactation, have been sectioned. In each case the sections have been photographed.

Histological analysis has been commenced on the udders of the 3 freemartins and 11 of the cows and has been completed for some of those previously reported. Up to the present time histological work has been conducted on 56 udders. This phase of the work is done by the Pathological Division of the Bureau of Animal Industry.

In addition to sectioning one-half of each of the five calf udders already mentioned, the glandular development of the opposite half was dissected out to show the type and extent of development at different ages. These dissections have proved particularly instructive, as they demonstrate not only individual variations in advancement and type of development but also show that each of the quarters of the udder is developed from an individual and distinctly separated unit.

In the preparation of udders for anatomical studies, the secretory system of at least two quarters is filled with formalin. The quantity held is measured and used as a basis for calculating udder capacity. In the case of eight cows and two freemartins the injection was by means of a gravity system, so designed as to furnish a 10-pound pressure at the point of injection. In six other cases the udders were filled, but because of abnormalities in the udder, or because of other experimental work which interfered, the capacity determined was not considered representative. The five calf udders were filled with a small syringe. In one case a small quantity of formalin was lost, but the quantities retained in each case were recorded as accurately as possible.

Since the beginning of this work udder-capacity studies have been made on 61 animals, as follows: 19 lactating cows, 18 nonlactating cows, 7 heifers, 2 freemartins, 7 calves, 1 nonlactating Angus cow, and 7 experimental Herefords.

Additional experiments with post-mortem milking of amputated udders have been confined to attempts to recover butterfat, rather than to determine quantity of milk in the udder at milking time. Analysis of data previously obtained was practically completed during the year and is nearly ready for publication.

Last year's annual report gave partial results of an experiment conducted in cooperation with the Division of Animal Husbandry,

Bureau of Animal Industry, for the purpose of determining the difference between the udders of dairy cows and of beef cows kept under dairy conditions. The production of a group of Herefords and the capacities of their udders were given. Subsequently, the seven udders have been sectioned, and the sections have been photographed. Also histological studies of the tissue have been made. The quantity of secretory tissue in these udders was very small, indicating that the animals of this breed can not produce very large amounts of milk because they do not possess the necessary equipment for liberal milk production. These findings are in harmony with those previously reported in connection with the detailed study of a highly specialized dairy cow and a highly specialized beef cow.

CONFORMATION AND GROWTH

Growth is usually measured by body weight or by a small number of body measurements, such as height, length, and circumference. Conformation can to a certain extent be recorded by means of photographs; but photographs, although of great value, do not lend themselves readily to tabulation or analysis. In any study of conformation, therefore, whether it be in relation to anatomy, producing capacity, etc., or for the purpose of showing individual differences and changes at different ages and stages of development, it is necessary to translate conformation into numerical values which can be tabulated. A set of body measurements when carefully selected and carefully taken makes it possible to determine not only size but also the proportions of the body which determine the animal's conformation. Photographs of both bulls and heifers are taken monthly until 6 months of age, at 9 months, and at 12 months, against a lined background. A set of measurements is taken of all females at 3, 6, 9, 12, and 18 months, and repeated in the first, second, and mature lactation periods, and again immediately before slaughter. During the year photographs of 232 heifers and 214 bulls 12 months of age or younger were made. A total of 223 sets of measurements were recorded. Of these, 142 were of heifers 18 months old or younger, 75 were of cows, and 6 were of bulls. Three sets of heifer measurements, 12 sets of the cows', and all of the bulls' were taken immediately before slaughter. Many proportions and factors based on the interrelations of body dimensions have been determined for all animals measured.

OTHER MATTERS STUDIED

In connection with the anatomical studies, measurement of the diameter as well as the weight and length of intestines has been commenced.

The significance of length and diameter of intestines is not definitely known, as the relation between these factors and the rate of passage of feed through the digestive tract has never been determined for individual animals. Provision has been made for determining the length of time between ingestion of feed and its appearance in the feces in order that the correlation between length, diameter, and weight of intestines and the rate of passage of feed through the digestive tract may be determined.

The rate at which individual cows yield their milk at milking time is of interest in connection with the development of the udder, its size and characteristics, its producing capacity, and the gross and microscopic structure and physical properties of the tissue as determined on post-mortem examination. The relative speed of releasing the milk can readily be determined for any cow milked by machine, and a system has been established which will make this information available for every cow in the herd.

An attempt was made to increase the milk flow of cows by means of electric current controlled by a special generator, but the results indicated nothing of value. In a previous report reference was made to the preparation of the skeleton of a registered Jersey bull. A detailed comparison has been made between this skeleton and that of the registered Jersey cow Sophie 19th of Hood Farm. This comparison throws light on the fundamental differences between male and female skeletons. A publication covering this study has been prepared.

FEEDING AND MANAGEMENT INVESTIGATIONS AT THE BELTSVILLE STATION

A NEW METHOD OF APPORTIONING GRAIN TO MILKING COWS

The practical trial of the method described in last year's report has been continued, and data on 31 Holsteins for 83 cow-months and 40 Jerseys for 163 cow-months have been kept. The Holsteins produced, on an average, about 35 pounds a day and the Jerseys 21 pounds. The Holsteins gained in weight 7 pounds a month and the Jerseys 5 pounds. The Holsteins declined in milk 8.2 per cent a month, the Jerseys 9.3 per cent. Judging from the gains in weight and the decline in production, it would seem that this system provides sufficient nutrients. Two other experiment stations, the State stations of Illinois and Nevada, are advocating similar plans of apportioning grain to milking cows. The results of our investigations are now being prepared for publication.

HEAVY VERSUS LIGHT FEEDING PRIOR TO CALVING

In this experiment it was intended that the cows should be put in good state of flesh by feeding 12 pounds of grain a day for two months previous to calving, to compare with the same cows put in only a medium state of flesh by feeding 4 pounds of grain a day for a similar period. It was found that this difference in quantity of grain had no material influence on the condition of the cows. Ten cows have comparable periods on heavy and light feeding. Of the 10 cows, 4 gave more milk for a 90-day period following calving when fed heavily, and 6 gave more when fed lightly. The lightly fed cows gave 6.5 per cent more milk and 9 per cent more fat than did the heavily fed. Observations made on these cows at time of calving indicated that there was no noticeable difference between the condition of those fed heavily and those fed lightly.

Although the attempt to bring about the state of flesh desired was not successful, the information obtained is valuable in indicating that two months is not sufficient time to make a cow fat, and also that liberal feeding before calving does not in itself lead to increase

in milk production. It probably shows, too, that in case it is found desirable to have cows fat at calving time, they must be so fed during lactation as to leave them in good condition at the time of drying off.

FEEDING HEMPSEED-OIL MEAL

Hempseed-oil meal, prepared under the direction of a specialist of the Bureau of Plant Industry, was fed to nine cows to determine the effect of this material upon the flavor and odor of milk. The milk samples were judged by the division of market-milk investigations of this bureau. No bad effects from feeding this meal were observed.

Palatability tests with these nine cows, as well as with other cows, indicated that hempseed-oil meal is fairly satisfactory as dairy feed. When a mixture of equal parts of hempseed-oil meal, wheat bran, and hominy feed was fed only one of the nine cows refused her feed more than once. Not enough of the meal was available to test the nutritive value of it.

FEEDING BEET PULP DRY AND WET

In view of the readiness with which dried beet pulp absorbs water, it seemed reasonable to suppose that if cows are allowed plenty of water to drink, soaking of the pulp might just as well take place in the paunch of the cow as before feeding. Feeding the pulp dry is decidedly more convenient than feeding it wet. A preliminary trial with two grade cows for two 12-day periods indicated that the dry pulp was fully as palatable as the wet, and the production of milk was as great in one case as in the other.

Twelve cows, in two groups of six each, were fed for 60 days by the reversal method. The beet pulp took the place of silage in the ration. The amount fed varied from 6 to 10 pounds per cow per day, depending upon the size of the cow. The pulp fed wet was soaked from one feeding to the next with three times its weight of water. Alfalfa hay, in such quantities as would be consumed, and grain sufficient to at least equal the Savage requirements were fed.

The cows produced 12,560 pounds of milk on the dry pulp and 12,536 on the wet pulp. They gained 71 pounds on the dry and 134 pounds on the wet pulp. When fed dry pulp they ate 5,420 pounds of hay. When fed wet pulp they ate 5,383 pounds of hay. Dry pulp was refused all, or in part, 5 times out of a possible 720; wet pulp, 27 times. Frequent observations showed no noticeable difference in the consistency of the feces due to the method of feeding the pulp. The cows were turned out in the yard for water twice a day. Dry pulp seems to be equal or superior to wet pulp as to amount of milk produced, amount of hay eaten, palatability, and laxativeness. Slightly greater gains in weight resulted when the wet pulp was fed.

Work was continued in the following lines of investigation: The palatability of hays, the variation in the butterfat test of milk from one milking to another, and the production and management of pasturage.

EFFECT OF INCOMPLETE MILKING

The object of this work is to find the effect of leaving 1 or 2 pounds of milk in the udder at each milking, upon the persistency of production, and the occurrence of garget.

Three grade Holstein cows on the north farm are being used. A-13 started on the experiment March 18 and A-14 and A-20 on March 10. A-13 calved in January and A-14 and A-20 in February. At the start of the experiment A-13 was yielding about 50 pounds of milk a day; A-14, 47 pounds; and A-20, 40 pounds.

A-14 and A-20 give down all their milk so readily that only 0.4 to 2 pounds can be obtained by massaging or stripping. A-13, however, still has in her udder about 5 pounds of milk when massaging starts. An effort is made to massage out about 3 of the 5 pounds each time. The teat cups are removed from A-14 and A-20 as soon as the flow of milk practically ceases. On one day of each week the milk remaining in the udder is stripped out by hand in order to find out how much is actually being left. The average amount left in the udder of A-13 is 2 pounds; of A-14, 1.5 pounds; and of A-20, 0.85 pound.

So far this practice has not led to garget or to any other trouble. An accurate check on the persistency of milk flow is impossible. The monthly decline is calculated by comparing the quantity of milk produced for the last five days of the month with that produced for a similar period the preceding month. Leaving a small quantity of milk in the udder does not seem to affect the persistency of production, as the percentage decline in milk flow for the first and second months, respectively, was 9.6 and 9.4 for the cows whose udders were not massaged and 6.9 and 12.6 for those that were massaged.

The time required to draw the milk is noted occasionally. Removing the teat cups immediately with little or no massaging seems to have shortened the time of milking slightly in the case of one cow; with the other two there has been no definite change in this respect.

WORK AT THE FIELD EXPERIMENT STATIONS

HUNTLEY, MONT., STATION

Investigations for comparison of the yields and feeding value of irrigated tame pasture grasses, when (1) grazed, (2) clipped and fed green, (3) cured and fed as hay, and (4) ensiled, have progressed satisfactorily. Two years' results are now available.

A cow in the herd recently finished a 365-day official record on alfalfa hay alone, during which she consumed 16,014 pounds of hay. Average daily consumption was 44 pounds and highest day's consumption, 60 pounds. She produced 14,401 pounds of milk and 484 pounds of butterfat at the age of 5 years 7 months. This work is being continued with two additional cows.

The maximum carrying-capacity work has continued with slight variation. This year 100 pounds of superphosphate was applied per acre, in addition to manure, which has been used in previous years. On an acre basis, 1.9 cows were pastured per day for a grazing season of 133 days, with the production of 7,304 pounds of milk containing 274 pounds of butterfat.

As in previous years sweetclover pasture did not prove highly successful, as difficulty was experienced in getting the cows to consume it.

Three sires were proved during the year. Records on sires previously proved are being kept.

A new proved herd sire, U. Neb. Klaver King No. 388329, was purchased. He will be bred for the most part to the daughters of Varsity Derby Allen. U. Neb. Klaver King is the fifth proved sire to be used at this station.

Four official records were completed during the year, as shown in Table 7.

TABLE 7.—*Official milk and butterfat production records completed at the Huntley station during the fiscal year 1930*

Cow No.	Milk	Butterfat	Age
	<i>Pounds</i>	<i>Pounds</i>	
H-31.....	16,677	559.5	6 years 2 months 14 days.
H-38 ¹	14,401	483.7	5 years 7 months 17 days.
H-13.....	19,800	605.0	10 years 2 months 15 days.
H-26.....	22,500	821.0	7 years 4 months 28 days.

¹ Record made on ration of alfalfa hay alone.

ARDMORE, S. DAK., STATION

The investigations on the comparative yields and feeding value of Sudan grass, as (1) grazed, (2) cut every 30 days for hay and silage, and (3) cut when mature for hay and silage, were seriously handicapped in 1929 because of a poor growing season. Due to the extremely dry weather, there was only one typical cutting of each type of hay. Weeds grew so prolifically that they made the first cutting of hay almost valueless from an experimental standpoint.

The grazed plot furnished 24.8 cow-days per acre. Hay and silage cut at 30-day intervals yielded at the rate of 1,473 and 1,444 pounds of dry matter per acre respectively. The mature hay and silage plots yielded at the rate of 705 and 828 pounds of dry matter per acre, respectively.

The hay cut at the immature stage was more palatable than that cut when mature.

The mature Sudan silage, however, kept better and was more palatable than the immature. In fact, the mature Sudan silage was rated as good as corn silage. This is contrary to the results at Huntley with grass silage, and may be due to some unknown cause in the ensiling of the immature Sudan grass.

Carrying capacity of crested wheatgrass, brome grass, and native grass for summer and fall pasture have been continued. Crested wheatgrass furnished 46.5 cow-days grazing per acre, whereas brome grass furnished only 36.6 cow-days per acre. Grain and hay were fed to supplement the pasture.

An ice well was constructed at the Ardmore station in order to get data for this region. The pit was dug round and was lined with concrete instead of wood as at Mandan. Some difficulty was experienced by melting during the warmer spells last winter. Apparently concrete is not suitable for this purpose, because the ice melted rap-

tidly after the pit was opened. Steps have been taken to insulate this pit with wood for next season's work.

Official records were completed last year, as shown in Table 8.

TABLE 8.—*Official milk and butterfat production records completed at the Ardmore station during the fiscal year*

Cow No.	Milk	Butterfat	Age
	<i>Pounds</i>	<i>Pounds</i>	
H-58.....	11,180	365	2 years 8 months 10 days.
A-52.....	13,893	467	2 years 4 months 11 days.
H-57.....	13,661	431	3 years 14 days.
A-53.....	12,482	425	2 years 5 months 3 days.
A-54.....	12,242	404	2 years 10 months 8 days.

MANDAN, N. DAK., STATION

The experimental work started in 1928 at this station to determine the value and practicability of ice wells for refrigeration on dairy farms on the northern Great Plains has been continued. The results thus far indicate that the ice well is practical.

On a well-drained spot near a well, a pit 8 feet square and 9½ feet deep was dug. The sides were boarded up with cheap lumber and the bottom covered to a depth of 1½ feet with coarse gravel to give good drainage. A small house with an insulated removable floor was built over the pit. The floor of this house was removed during freezing weather. In freezing weather a quantity of water sufficient to form a thin layer of ice was run into the pit every day or two. After sufficient ice was formed the floor was replaced. A wooden rack or basket, suspended from an overhead pulley, served for raising and lowering milk cans through an opening in the floor.

Freezing was started in January, and by the end of February a solid cake of ice 8 feet square and 6½ feet deep had formed in the pit. The mean average temperatures for January and February were -2.9° and 4.6° F., respectively. The maximum was 38°, and the minimum was -43°.

Storage of milk and cream was started May 25. The ice in the pit lasted until September 28, a period of 126 days.

Temperature records were carefully kept. Small quantities of cream cooled with well water to 56.5° F. and placed in the pit were cooled to 48° in three hours and to 42° in eight hours. Cream placed directly on the ice was cooled to 34° in the same period. Small quantities of cream in cans (20 to 30 pounds) kept in a perfectly sweet condition for 14 days in July. The temperature in the pit varied from 44° to 50°.

The mean average weather temperatures in June, July, and August were 62.9°, 73.6°, and 70.6° F., respectively. The highest temperature recorded in the three months was 106°.

Meat, fruit, and vegetables also kept perfectly in the pit. No offensive odors were detected at any time.

Last winter the ice well was again frozen full of ice, and additional data are now being secured on this summer's storage.

The State of North Dakota has given the United States Department of Agriculture a lease on a section of land for the use of the

dairy experiment station. This section, together with the quarter section already owned, makes a total of 800 acres in the dairy experiment farm. That portion most suitable is being seeded to alfalfa, and the rest will be used as pasture.

Table 9 gives the acreage and yield per acre of crops grown in 1929.

TABLE 9.—*Yields per acre of crops grown at Mandan station, 1929*

Crop	Area	Yield per acre	Crop	Area	Yield per acre
	<i>Acres</i>	<i>Bushels</i>		<i>Acres</i>	<i>Tons</i>
Oats.....	27.8	17.8	Corn silage.....	22.2	2.88
Barley (Trebi).....	11.0	27.0	Sudan-grass hay.....	7	1.62
Barley (C. B. S. 80).....	24.6	19.4	Alfalfa hay (1 cutting).....	30	.50

The oat yield was very low, due to lack of moisture. The Trebi barley gave a much better yield than the C. B. S. 80. Corn silage yielded about the same as the year previous. The alfalfa is on land that is not suitable and will be plowed up this fall.

Some experimental work was started on grain hays. A small acreage has been seeded to a variety of oats suitable for the production of oat hay in this locality. Yields and nutrients produced per acre will be compared with other hays grown. Several acres of sweetclover seeded in 1928 are being pastured this year.

The herd has done remarkably well during the year. Table 10 gives the official production records completed during the year.

TABLE 10.—*Official milk and butterfat production records completed at the Mandan station, fiscal year 1930*

Cow No.	Milk	Butterfat	Age
	<i>Pounds</i>	<i>Pounds</i>	
H-64.....	15,215	522.0	2 years 6 months 21 days.
H-65.....	15,796	577.7	2 years 5 months 21 days.
H-66.....	15,884	536.0	2 years 4 months 24 days.
H-67.....	12,967	457.9	2 years 4 months 18 days.
H-69.....	10,384	381.7	2 years 6 months 7 days.
W-204.....	12,028	403.2	2 years 6 months 24 days.
A-24-U.....	19,053	654.7	2 years 3 months 27 days.

The first five heifers are daughters of Friend Ona Hartog Korn-dyke 277648 (A105). This Holstein bull was proved and used at the Huntley, Mont., station for several years, in the proved-sire succession project. The heifer A-24-U is a daughter of Korndyke Walker Pontiac Prince (H-257), a bull proved at the Huntley station and now in service at Utah State Agricultural College. Four 2-year-old daughters of Sir Bess Rue North Star 470775, a proved sire, have been purchased and added to the Mandan herd. Six young bulls have been placed with cooperators to be proved.

WOODWARD, OKLA., STATION

The experiments on yield and comparative feeding values of Sudan hay, cut at (1) first-heads-out stage, (2) fully headed stage, (3) soft-dough stage, and (4) 30-day stage, have now progressed for two years. The results thus far are very interesting.

The Sudan hay that was cut when first heads were out yielded about the same amount of air-dry hay and dry matter per acre as that cut at the fully headed and soft-dough stages, but produced 1,796 pounds more air-dry hay than that cut every 30 days.

In yield of crude protein per acre, first-heads-out hay was far superior. The percentage of crude protein dropped decidedly as the hay matured.

In experiments comparing a trench silo with an upright silo for kafir silage the former compared favorably with the latter in preservation of the silage and recovery of edible silage. Eighty-one per cent of original material was recovered as edible silage in the trench, and 85 per cent in the upright. The total labor cost of hauling, filling, and removing from silo was \$1.01 per ton for the trench and \$0.45 per ton for the upright silo. This does not take into consideration interest on the investment and upkeep.

The carrying-capacity pasture investigations on orchard grass, Sudan grass, and sweetclover have continued without interruption.

Six daughters of Count Piebe Watson Hero 311691 completed semiofficial records during the fiscal year, as shown in Table 11.

TABLE 11.—*Official milk and butterfat records completed at the Woodward station during fiscal year 1930*

Cow No.	Milk	Butterfat	Age
	<i>Pounds</i>	<i>Pounds</i>	
W-33.....	16, 425	495. 3	4 years 4 days.
W-40.....	12, 516	362	2 years 11 months 12 days.
W-42.....	9, 500	343	2 years 11 months.
W-45.....	13, 023	369. 5	2 years 1 month 18 days.
W-47.....	11, 893	348. 6	1 year 6 months 27 days.
W-48.....	13, 881	415. 9	2 years 12 days.

All of these cows, excepting W-47, are inbred; that is, they are the offspring of a sire mated to his daughters.

The records made at all of the field stations are comparable, in that the cows are all kept in stanchions, are milked three times a day for 365 days, and are fed at approximately the same rate.

The first three daughters of King Paul Helena Walker 348317 (H-112), the present herd sire, who was bred in the Huntley herd and proved out at Huntley, recently freshened and are doing well on test. In 108 days W-50 produced 5,014 pounds of milk and 171 pounds of butterfat. In 50 days W-51 produced 2,370 pounds of milk and 77 pounds of butterfat.

A new proved herd sire, Sir Bess Rue North Star 470775, was purchased and is now in service. He will be bred to the daughters of King Paul Helena Walker. Daughters of Sir Bess Rue North Star now in test in Iowa dairy herd-improvement associations are producing at a remarkable rate.

JEANERETTE, LA., STATION

Investigations on the effect of rotating and of top-dressing native grass pastures with 200 pounds of superphosphates per acre produced some interesting results.

An unknown disease has appeared in the herd. A beadlike fungous growth started in the nostrils of several heifers, causing them to breathe with difficulty. About 10 head are now infected. Physiologists and veterinarians of the department have so far been unable to diagnose or cure the disease.

On June 30 an engorged cattle-fever tick was found on one of the heifers. Dipping of the entire herd was started and will be continued until danger is past. Five register-of-merit records were completed during the fiscal year, and they are shown in Table 12.

TABLE 12.—*Register-of-merit records completed by cows in the Jeanerette station herd during the fiscal year 1930*

Cow No.	Milk	Butterfat	Age
	<i>Pounds</i>	<i>Pounds</i>	
48.....	6,304.9	330	5 years 7 months 9 days.
61.....	8,592	443.6	3 years 5 months. ¹
70.....	7,500	389	2 years 9 months 4 days. ²
71.....	6,782	417.19	2 years 6 months 3 days.
73.....	11,674	531.13	2 years 7 months 7 days.

¹ Record for 305 days; cow died of toxic pneumonia.

² Estimated.

PONTIAC (SAND HILL), S. C., STATION

A dairy barn of the open-pen type, a milking barn for eight cows, and a milk house, have been built.

Considerable time and effort have been spent in getting a suitable pasture established. The extreme sandy condition of the soil made this a difficult undertaking. The resulting pasture, however, is well established and far exceeds expectation. The Bureau of Plant Industry has been cooperating in the pasture work.

LEWISBURG, TENN., STATION

Twenty-six registered Jersey females and one proved bull were purchased as a foundation herd for this station. The bull, Goldies Torono Lad 188012, is a proved son of Hillside Emperor 149368, and is out of a daughter of Hillside Torono. Ten of the females are daughters of Pangenesis 231578, a son of Interested Vendas Prince. Pangenesis was bred and proved at the Jeanerette, La., station.

Goldies Torono Lad has 28 daughters which averaged 9,525 pounds of milk and 489 pounds of butterfat in dairy herd-improvement associations (mature basis). Their 28 dams averaged 7,722 pounds of milk and 419 pounds of butterfat (mature basis). The daughters excelled the dams by 1,803 pounds of milk and 70 pounds of butterfat, on the average.

The following buildings have been remodeled or built or are now near completion: Superintendent's house, remodeled; dairyman's house; 40-cow pen barn; 60-cow milking barn, remodeled; calf and young stock barn; office and laboratory; 2-car garage; hay barn remodeled; 8-cow milking barn; and a milk house.

Robert Gaalaas, agent in dairying, who has been a cooperative employee at the Huntley, Mont., station, was transferred to the Lewisburg station in the capacity of herdsman. Considerable attention has been devoted to a cropping system for the 500-acre farm.

The following crops have been planted for this year: Barley, cover crop, 15 acres; oats for hay and grain, 25 acres; corn for grain and silage, 50 acres; soybeans for hay, 28 acres; alfalfa, to be seeded in August, 7 acres; and Sudan grass for hay and pasture, 16 acres.

A complete set of farm and farming implements, including a tractor, plows, harrows, hay loader, mowers, etc., has been purchased. A dryer for the artificial drying of grasses and hay has been bought and is being tried out.

GENERAL

In February the men in charge of the dairy work at the various stations were in Washington for a week's conference, at which plans were made for the development of the work and conferences were held with various specialists of this and other bureaus. This was the first time these men had visited headquarters. The knowledge of the bureau's work which they gained has been of great assistance to them in their work at the field stations.

The new-type milking outfits, by which the milk is drawn from the cows by machine, then automatically weighed and later drawn through an overhead pipe into a large vacuum tank in the milk room, are being installed at all the stations. This standardized system of milking will do much toward standardizing the methods under which the production records are made at the stations.

Abortion-control work is continuing at the two stations (Jeanerette, La., and Mandan, N. Dak.) that have infected cows.

Bull-proving work has progressed materially. At some of the stations it has been necessary to drop a few cooperators because of their not furnishing records. At most of the stations there is a waiting list of men desiring to take up this cooperative work.

The number of animals of various classes, and the number of bulls placed with cooperators for proving are shown in Table 13.

TABLE 13.—Status of field-station herds as of June 30, 1930

Station	Cows	Heifers	Heifer calves	Herd bulls	Bull calves	Bulls placed with co-operators	Cows in cooperators' herds
Huntley, Mont.....	22	16	3	3	9	36	650
Ardmore, S. Dak.....	19	6	7	2	3	12	300
Mandan, N. Dak.....	10	10	2	1	6	6	125
Woodward, Okla.....	24	17	4	2	6	17	250
Jeanerette, La.....	22	12	4	3	17	26	811
Pontiac, S. C.....	4	7	1	1	2		
Lewisburg, Tenn.....	11	16	1	1	5		
Total.....	112	84	22	13	48	97	2,136

FEDERAL PENITENTIARIES

Close contact has been maintained with the Department of Justice in the operation of the five Federal-prison herds. All of the penitentiaries were visited during the year, and assistance given in care, feeding, and management problems. A foundation herd of Holsteins, 84 in number, was purchased for the Chillicothe institution. Assistance has also been given in planning new barns for the various prisons.

DIVISION OF MARKET-MILK INVESTIGATIONS

ERNEST KELLY, *in Charge*

BELTSVILLE DAIRY FARM

Supervision of the sanitary conditions at the United States Dairy Experiment Station at Beltsville, Md., was continued throughout the year. The pasteurization of cream has been continued, and 294 samples have been tested for bacteria and butterfat, with the following results: Average butterfat, 32.6 per cent; average bacterial count, 2,700 per cubic centimeter; low bacterial count, 100 per cubic centimeter; high bacterial count, 300,000 per cubic centimeter. The range in bacterial count was: Under 1,000 per cubic centimeter, 220 samples; 1,001 to 10,000 per cubic centimeter, 63 samples; 10,001 to 50,000 per cubic centimeter, 9 samples; 50,001 to 100,000 per cubic centimeter, 1 sample; and more than 100,000 per cubic centimeter, 1 sample.

Late in the summer and early in the winter some trouble was experienced with high counts obtained from one of the milking machines. In January, 1930, recommendations were made for changes in the procedure of caring for the machine. From July 1, 1929, to January, 1930, the milk from the machine had contained an average of 69,446 bacteria per cubic centimeter. A special investigation was made in January which showed the machine to be producing milk at that time with an average bacterial count of 35,135 per cubic centimeter. A new procedure for the sanitary care of the machine was inaugurated. Since that time the average count of milk as taken from the storage tank has been 3,070 per cubic centimeter. The highest average count on any one inspection was 4,400 per cubic centimeter, and the lowest 1,320 per cubic centimeter.

COLUMBIA INSTITUTE FOR THE DEAF

Eleven samples of mixed milk taken at different times throughout the year had an average bacterial count of 8,380 per cubic centimeter.

UNITED STATES NAVAL ACADEMY DAIRY

Inspection of the United States Naval Academy dairy at Gambrills, Md., was continued during the year. Conditions were found to be satisfactory. Through May, 1930, nine inspections were made. The average score was 97.5, or 0.2 higher than last year. The scores ranged from 97.3 to 98. One hundred and fifty-seven samples were taken for bacteriological examination. Of these, 130 were taken directly from the milk pails at the barns. They ranged in count from 100 to 50,000 per cubic centimeter, the average count being 1,723 per cubic centimeter (last year's count was 2,390). Two of the samples showed "pin-point" colonies indicative of garget and had counts of 9,800 and 50,000. Eliminating these two counts, the average would be 1,280 per cubic centimeter. Last year's average without "pin-points" was 1,330 per cubic centimeter.

Twenty-seven samples of the mixed milk in the cans were obtained. The average count was 2,170 per cubic centimeter.

In May recommendations were made that all employees coming into contact with milk or milk containers be given physical exami-

nation and that laboratory examination of specimens from these people be made.

FLY CONTROL

In the summer of 1929 fly-control work was continued at the Beltsville farm as in former years. Spraying was not done so often and so regularly as it should have been, with the result that nearly 47 gallons of flies were caught in six traps at the home farm, an increase of about 60 per cent over the 1928 catch, when eight traps were used. One hundred and sixty gallons of spray was mixed, as compared with 220 gallons in 1928. This was the first year in which the manure shed was available. There are too many openings and a satisfactory way will have to be devised to close them tightly.

Some preliminary work was done late in the summer to determine the influence of flies and spraying upon the milk flow. This work was started too late, and the sprayers broke down, so sufficient information is not available to form the basis for definite conclusions. It is planned to continue this work the coming summer. Some cooperative work was done with the Bureau of Entomology. It was found that flies emerged after the manure was spread upon the fields. In the work conducted, doubling the amount spread over a given area gave double the emergence. Some work was done on the effect of different baits, but no conclusion was reached.

STUDIES IN MECHANICAL REFRIGERATION FOR DAIRY FARMS

In August and September, 1929, in cooperation with the Bureau of Public Roads, some preliminary surveys were made in regard to mechanical refrigeration for dairy farms. It was decided to continue this work next year.

VOCATIONAL SCHOOLS

In 1929 instruction was given in 1,429 vocational schools on the judging of milk. After State competitions, teams were selected from 16 States, and these teams competed in a national contest held in connection with the National Dairy Exposition.

At the request of the Federal Board for Vocational Education this bureau explained to the board's regional directors the importance of the production of milk high in quality. The regional directors were enthusiastic over this project, and as a result subject-matter specialists from this division have been working with subject-matter specialists of the board, and a tentative set-up has been prepared from which a teaching project can be developed by the vocational teachers. These lessons are divided into nine jobs, each of which is subdivided into a number of separate operations to be performed by the student. The method of performing these operations is fully described under the heading of "Standard or accepted practice," which accompanies the job descriptions. It is believed that the development of this particular work will have very far-reaching effects on the effort to get production of milk of higher quality.

STUDY OF AREA MILK CONTROL IN MONROE COUNTY, N. Y.

Early in 1929 this division sent a representative to Rochester, N. Y., to work with the newly organized Monroe County department

of sanitation. Advice was given as to methods of inspection, laboratory control, and organization. During this time a study was made of conditions on the dairy farms and in the distributing plants supplying the county with milk. In general, there was a lack of proper equipment on the farms, and the methods used were far from satisfactory. Eight months later a return visit was made in order to observe what progress had been made. In this second survey a thorough inspection of existing conditions was made, which revealed that great progress had been made both on the farms and at the plants.

The inspectors have been able to bring about remarkable progress along lines of better equipment. At the beginning of the work about 28 per cent of the farmers were straining milk in the barn. This practice has been stopped, and at present practically no milk is being so handled. Inspections of the farms also showed that there has been a successful effort made in many cases to bring about general improvement in surroundings.

Approximately 4,000 quarts of pasteurized milk, which was sold as raw milk before the department was organized, is now available. This amount will be considerably increased when a new plant is put into operation. Eleven pasteurizing plants are now in operation and supply Monroe County with pasteurized milk. These plants are equipped with the necessary apparatus for the proper operation of pasteurizing plants.

This work has been carried on by the director, two inspectors, and one veterinarian. In addition to the dairy work, sanitary work dealing with water supplies, sewage disposal, and wayside stands has been undertaken by the same personnel.

BACTERIOLOGICAL STUDIES IN MILK PLANTS

The data for this investigational work may be summarized as follows:

The average pasteurization efficiency, as determined by reduction in total count, was 97.33 per cent for 481 pasteurizing runs made at 97 plants.

There was an average increase of 13.99 per cent in bacterial count of the samples taken at the bottom of the cooler over the count of the pasteurized milk immediately after pasteurization.

A further average increase of 12.98 per cent was found in samples of milk from the bottles.

After 24 hours' storage the increase was 7.34 per cent.

The total average increase in bacterial count due to cooling, bottling, and storage was 38.11 per cent. This increase was based upon the average count of the milk immediately after pasteurization.

Forty-one samples of pasteurized milk showed pin-point colonies.

When these 41 runs were averaged the following results were obtained:

	Per cent
Pasteurization efficiency.....	97.33
Decrease in average bacterial count from pasteurizer over cooler.....	13.99
Decrease in average bacterial count from cooler to bottle.....	12.98
Decrease in bacterial count due to 24 hours storage.....	7.34
Total decrease from pasteurizer through storage.....	38.11

Twelve runs pasteurized at 140° to 141° F. showed a pasteurization efficiency of 96 per cent, whereas 457 runs pasteurized at temperatures ranging from 142° to 148° gave efficiencies ranging from 97.19 to 98.34 per cent.

When pin-point samples were eliminated from the data, the percentage efficiency for pasteurizing temperatures ranging from 142° to 148° F. was raised from 97.73 per cent to 98.69 per cent.

Fifty-five samples stored for 24 hours at an average temperature below 40° F. showed a decrease of 2,163 per cubic centimeter; 135 samples stored at an average temperature ranging from 40° to 44.9° gave a decrease of 587 per cubic centimeter; whereas 55 samples held at an average temperature of over 45° (highest average, 50.8°) showed an increase in count of 15,688 per cubic centimeter.

Average increases in temperature due to bottle filling were 5.5°, 5°, and 5.1° F. for half pints, pints, and quarts, respectively.

Average air temperatures in stacked cases varied during a 5-day period from 6° to 24° F. No uniformity as to variation was noticed between top, middle, or bottom of stack.

Temperatures within the storage room varied greatly during a 5-day period. Average variations for various points were as follows: 12.5°, 12.7°, and 13.7° F. The extreme average variation for 29 storage rooms was 18.37°. The most even temperature found was in a room which showed extreme average variation of 7.8°; the highest or most uneven temperatures were in a room showing an average extreme variation of 28°. One room showed at one point a temperature of 72°.

Average hourly temperature of storage rooms does not always indicate continuous low-storage temperature. One room with a daily average hourly temperature of 45.8° was above 50° F. for eight hours.

QUALITY-MILK PROJECTS

To stimulate and assist in the development of a comprehensive plan for raising the general level of quality of milk throughout the United States a great deal of intensive work has been done, not only in planning programs but in the actual introduction of the work in a number of States. Suggested programs were drawn up for use among adults and boys and girls of the 4-H Clubs. These programs were worked out by the subject-matter specialists of this division with the extension dairymen and were then submitted to the office of cooperative extension work for suggestions and criticisms. Final forms were reached, which have been mimeographed and distributed to the extension workers throughout the United States. These mimeographed leaflets take up the methods to be followed, phases of the work, the organization of the work, and methods of measuring results. For the 4-H Clubs there have been worked out a very complete procedure, which is covered through 12 meetings. In these club meetings the fundamentals in the production of high-quality milk are thoroughly treated and demonstrated by means of actual club work. The first work done under this project was in Maine. A conference was held at which were present the State dairy specialist, the Boston, Mass., milk inspector, a representative of the State Department of Agriculture of Massachusetts, and representatives of the New England Milk Producers' Association and various commercial companies.

Meetings for the introduction of the program were held at Conway, Ark., Athens, Ga., and Ocala, Fla. Contacts were made with the State extension services and various departments of health, both State and local. In each State lectures and organization meetings were held, accompanied by demonstrations of methods used in carrying out the work. It is the intention to revisit these localities where work is now being carried on at periods of about a year to observe what improvements have been made in milk supplies, and also to study the applicability of the methods suggested and to determine whether any methods should be changed, dropped, or added.

The 4-H club project is in active operation in New Jersey, and at the Eastern States exposition last fall a boys' club team demonstrated the methylene-blue test. This demonstration created a great deal of interest at the exposition.

In 8 of the 11 Northeastern States which have State dairy extension specialists there are quality-improvement projects in the State plans of work, and 2 States have plans for 4-H club work. Four States are actually operating the adult area quality-improvement work and 2 or 3 have taken up actively the 4-H club work.

MISCELLANEOUS INVESTIGATIONS

TANK TRANSPORTATION OF MILK

Data were completed on tank transportation of milk. This study includes results of a survey of 300 tank trucks, 89 trailers, and 53 tank cars, together with personal observation on 82 tank trucks, 29 trailers, and 28 tank cars. It is concerned with length of routes, temperature variations, methods of handling at plants, washing of tanks, and the handling of milk in tanks as compared with handling by cans. The cost per hundredweight mile varies from \$0.0017 to \$0.0049, with an average of \$0.00273 per hundred weight mile. The average cost of hauling for those using trailers is \$0.0023 per hundredweight mile, and for those not using this type of equipment the average cost is \$0.0034 per hundredweight mile.

Some advantages of tank hauling are: (1) More control over product with less care; (2) more sanitary; (3) less can investment; (4) less loss of product; (5) less labor at country plants; (6) city plants can handle more milk with same area; (7) saving in washing; (8) advertising medium; (9) less floor space required in plants; (10) with tank trucks country stations can be located at advantageous points without reference to railroads; (11) eliminates cartage between terminals and city milk plant; and (12) greater flexibility than any other method.

THE VISCOSITY OF CREAM

Work on this project has been completed. The conclusions reached will be published soon in a technical bulletin.

EFFECT OF FEEDS ON THE FLAVOR AND ODOR OF MILK

In cooperation with the Bureau of Plant Industry, an experiment was conducted to determine the effect of hempseed-oil meal on the

flavor and odor of milk. This feed seemed to affect neither the flavor nor the odor of the milk produced.

LABELING REQUIREMENTS ON MILK-BOTTLE CAPS

A compilation of the wording required by law on milk-bottle caps was made from a study of 23 State and 410 city milk or health ordinances that were reported as being in effect in 1928. These data are now available in tabular form.

MILK-PLANT MANAGEMENT

STUDY OF BOTTLE LOSSES AND METHODS USED TO REDUCE THEM

Data on bottle losses other than plant breakage were obtained in Boston and Springfield, Mass., Waterbury and Hartford, Conn., and New York City. It is hoped to get more data bearing upon certain points in this investigation. More information is also wanted on the effect of plant and equipment arrangements on the breakage of bottles. A bulletin on this investigation is being prepared.

COUNTRY MILK-RECEIVING STATIONS

Studies of country milk-receiving stations were conducted in Detroit and New York during the year. Data were obtained on the following items: Time receiving and weighing milk, layout of plant with special reference to the arrangement of receiving room, floor space, number of men employed, sewerage and ventilating systems, water supply, costs for coal and electricity, method of refrigeration, and size and type of such equipment as boilers, refrigerating machinery, motors, etc.

STUDY OF SMALL MILK PLANTS

The main work accomplished has been the organization, expansion, and writing up in bulletin form of data on the construction and arrangement of small milk plants.

DIVISION OF HERD-IMPROVEMENT INVESTIGATIONS

J. C. McDOWELL, *in Charge*

The investigational work of the division was continued along lines similar to those of previous years. Considerable attention was given to the following matters.

CULLING OUT LOW PRODUCERS

A study has been made of the effect of culling out low-producing cows from the herd. It was found that the culling out of the lowest-producing 1 per cent from average herds—that is, from herds having an average milk production per cow of approximately 4,600 pounds and an average butterfat production of approximately 180 pounds—would result in eliminating one-fourth of 1 per cent of the total production of butterfat. The cows were culled on the basis of production of butterfat and not milk production.

By applying the results of culling average herds to all the herds in the United States the figures shown in Table 14 are arrived at:

TABLE 14.—*Effect of culling average herds, the average per cow production of which is 150 to 199 pounds of butterfat*

Cows culled	Butterfat eliminated by culling	Days of Nations' supply which would be cut off by culling indicated
<i>Per cent</i>	<i>Per cent</i>	<i>Number</i>
1	0.25	1.0
2	.65	2.4
3	1.1	4.0
4	1.6	5.8
5	2.1	7.7
10	5.1	19.0
20	12.3	45.6

These figures do not exactly represent the average of the dairy herds of the United States, but the average production is about that of the average of all herds. According to these figures the culling out of the lowest producing 1 per cent of our dairy cows would eliminate 0.25 per cent of the butterfat supply, or approximately one day's supply. The culling out of 2 per cent would, according to the same reasoning, eliminate 0.65 per cent of the butterfat, or 2.4 days' supply. The culling out of the lowest producing 10 per cent of the dairy cows would cut down the supply of dairy products 5.1 per cent, and eliminate enough dairy products to last the United States 19 days.

A further study of culling showed clearly that the lowest producing 10 per cent of the cows on test in dairy herd improvement associations are not returning a profit to their owners. The same was found to be true of the herds of registered dairy cattle. For example, the average butterfat production of all mature cows on test for one dairy breed in 1928 was 330 pounds a year. The lowest producing 10 per cent average 179 pounds per cow, and they returned an average of \$53 over cost of feed. The cost of their feed was \$73 per cow, or \$20 more than the income over cost of feed. If these cows produced any profit it must have been extremely small.

SIZE OF COW AND SIZE OF HERD

Size-of-cow and size-of-herd studies were continued. The results were similar to those given in former reports.

The tabulations thus far made on size of herd have shown a higher production of milk and butterfat per cow for the herds under 10 cows than for the larger herds. The herds that averaged from 11 to 20 cows per herd showed a slightly higher production of butterfat per cow than those which averaged from 21 to 30 cows per herd.

SEASON OF FRESHENING

Studies relating to season of freshening and month of freshening have been continued. For most parts of the country the results have favored fall and early winter freshening. As a rule, the cows that

freshened in the fall and early winter excelled all others in production of milk per cow, in production of butterfat per cow, and in return over cost of feed per cow.

UNIFORM RULES FOR HERD TESTING

This division was asked to draft a set of rules for the testing of entire herds of registered cows for production of milk and butterfat. The idea was to make the rules uniform for all breeds. The rules worked out here were accepted, with only a few minor changes, by the rules committee of the American Dairy Science Association and the national dairy breed associations. The rules have since been adopted by the advanced-registry section of the American Dairy Science Association, and the rules are soon to be presented to the breed associations for final action. The purpose of making the rules uniform is to facilitate the testing work.

MEASURING GAINS AND LOSSES OVER A PERIOD OF YEARS

Yearly production and income records per cow have been compared over a period of years for the same herd, the same association, the same State, and for the United States. The averages have usually shown a gain from year to year but not always. Table 15 gives figures which show, for one herd, the value of the dairy herd improvement association work.

TABLE 15.—The record of a herd that gained in milk production and profits

Year	Cows	Milk per cow	Butterfat per cow	Cost of feed	Income over feed cost per cow
	Number	Pounds	Pounds	Dollars	Dollars
1926.....	23	4,680	249	96	56
1927.....	15	6,750	350	121	104
1928.....	11	7,359	373	129	109

These figures show a gain each year in production and in income over cost of feed per cow. The records will be kept for many herds over a period of many years. Table 16 shows what it is possible for a dairy herd improvement association to do in building up production and increasing profits for its members.

TABLE 16.—The record of an association which gained in production and profits

Year	Cows	Milk per cow	Butterfat per cow	Cost of feed per cow	Income per cow over feed cost
	Number	Pounds	Pounds	Dollars	Dollars
1926.....	282	6,890	297	76	100
1927.....	214	7,156	307	77	110
1928.....	263	7,485	332	88	120

Many other associations show similar gains over longer periods of years. Table 17 is a general summary of all records available to the bureau.

TABLE 17.—*Summary of all records available*

Year	Cow years	Milk per cow	Butterfat per cow	Cost of feed per cow	Income per cow over feed cost
	<i>Number</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Dollars</i>	<i>Dollars</i>
Previous to 1920.....	37,362	5,989	247	53	59
1924.....	32,091	7,092	279	68	94
1925.....	98,704	7,189	284	67	89
1926.....	127,617	7,316	289	69	101
1927.....	142,084	7,410	293	72	112
1928.....	201,590	7,464	295	77	116
1929.....	262,996	7,451	296	80	117

The figures in Table 17 show a gain in production of milk and butterfat, and income over cost of feed per cow.

ANALYSIS OF RECORDS VALUABLE TO STATES

As the records of dairy herd-improvement association cows are received by the bureau they are tabulated and summarized and returned to the States from which they were received. A special feature has been to send with the summaries a letter explaining the outstanding points of information contained in the summaries. The analysis of the records has been greatly appreciated by the States, and it has been of great assistance to them in relaying the information to dairymen.

FEED STUDIES

A study of the feed records of about 100,000 cows is being made. A tabulation of the different kinds of feed, with special reference to the protein content of roughages and concentrates, is under way. This study of feeds, tabulated by States and by geographical regions, is expected to furnish valuable information to dairymen, and to result in more economical production.

PROVED-SIRE INVESTIGATIONS

This was the first year that the subproject, proved-sire investigations in dairy herd-improvement associations and bull associations, has been conducted as a strictly investigational project. During the year 5,781 dam-and-daughter records were reported by the herd-improvement associations. Of this number 327 bulls were proved, and 1,824 bulls were partly proved. An innovation in the proved-sire work last year was to send information to the States on the sires that were partly proved. This additional information has, to a very large extent, been responsible for the renewed interest that the State dairy specialists and testers are taking in the proved-sire work. In the last six months of this year 841 more dam-and-daughter comparisons were received than were received during the entire calendar year of 1929. In connection with this work a complete summary of the sires proved and partly proved, by States, was issued on January 1. A bull-association directory was issued also. The subjects being studied are: (1) To what extent do the records of the ancestors of a sire indicate the production of his progeny; (2) comparison of the records of the daughters of proved sires with the records of their dams;

(3) comparison of production records of average dams and their daughters; and (4) results of mating sires with cows of different butterfat production.

DIVISION OF MANUFACTURING INVESTIGATIONS AND INTRODUCTION

WILLIAM WHITE, *Acting in Charge*

The work of this division was on the following projects: Creamery introduction, Cheddar-cheese factory introduction, introduction of the culture method of making Swiss cheese, introduction of the manufacture of concentrated sour skim milk, introduction of the grain-curd method of making casein, supervision of the Grove City creamery, and renovated-butter factory inspection.

In addition to the work on these main projects this division cooperated with the laboratories division of the bureau in work on canning Cheddar cheese; cooperated with the Office of Exhibits of the Extension Service by supervising exhibits at State fairs; conducted students' contests in judging dairy products at the Eastern States Exposition, Springfield, Mass., and the National Dairy Exposition, St. Louis, Mo.; conducted a scoring of dairy products (butter, cheese, milk, and ice cream) for instructors in agricultural colleges at the summer meeting of the American Dairy Science Association in which 36 men from 15 colleges participated.

SHORT COURSES

In accordance with the custom of the last few years, one of the division's manufacturing specialists served as an instructor in Swiss-cheese making at short courses held by the University of Wisconsin and Ohio State University. Assistance was also given at a 1-week buttermakers' short course at the University of Arkansas, a 1-week dairy-manufacturing short course at the University of Tennessee, and a dairy-manufacturing short course at Pennsylvania State College.

CREAMERY INTRODUCTION

Introduction of the best methods of creamery operation was continued in Alabama, Tennessee, Mississippi, South Carolina, and Arkansas for all or part of the year. This work was conducted in close cooperation with the State agricultural colleges. In all five States educational butter scorings were conducted monthly or bi-monthly. A large percentage of the creamery men are interested in these scorings and find them an excellent means of checking up on the quality and composition of their butter. A much larger percentage of the creameries in these States participate in these scorings than is the case in the older dairy States.

In Tennessee marked progress was made in getting creameries to purchase cream for butter making on a basis of grade or quality. The creameries in this State, which in the past have made high-scoring butter, report that they have not been successful in finding good markets for their high-grade product at satisfactory prices. For several years the cooperative and local creameries, with the help of a specialist of this bureau, have cooperated in assembling car lots

of butter to be shipped to eastern markets. This butter is now being sold on a quality basis, and the bureau specialist has established a cream-grading system at the participating creameries. Under this system the farmers receive for their high-quality cream a price of 3 cents a pound of butterfat higher than that paid for cream of lower quality. Under this system the quality of cream received at the creameries has materially improved.

The ability of Tennessee creameries to make high-quality butter is indicated by the showing made at the 1929 National Dairy Exposition, where they won fourth place in average score of butter exhibited.

In Alabama, Arkansas, Mississippi, and South Carolina educational cream scorings were conducted at a few creameries under supervision of a bureau specialist as a means of paving the way for the purchase of cream on a quality basis.

IMPROVING QUALITY OF CHEDDAR CHEESE

This work was conducted in States in which the making of Cheddar cheese on a factory scale is a comparatively recent undertaking. In these newer cheese-making sections many factories are encountering difficulties in producing a high-quality product. Of 37 cheese factories visited, 17 were making cheese of high quality, 15 of fair quality, and 5 of poor quality. As an example of what is being accomplished in this work, at one factory the cheese specialist of the bureau found that the cheese was high in acid and was gassy and the yield per 100 pounds of milk was low. The cheese maker was shown how to overcome these defects, with the result of an increase of \$700 a month in the market value of the cheese.

INTRODUCTION OF THE CULTURE METHOD OF MAKING SWISS CHEESE

In making Swiss cheese under commercial conditions new problems have been encountered which require additional experimental work. As results of this experimental work become available they are applied to the work in the field.

In Ohio each year additional factories request the services of the cheese specialist, and 18 factories are now receiving assistance from the bureau in applying the culture method in their factories.

The improvement in quality as a result of this method is illustrated by the fact that at the Ohio State Fair in 1929 of 12 Swiss cheese exhibited the first 5 places were won by factories using the bureau's culture method.

It is estimated that as a direct result of the use of this method payments to farmers for milk delivered at Swiss-cheese factories in Ohio were increased by at least \$15,000 for the year.

INTRODUCTION OF THE GRAIN-CURD METHOD OF MAKING CASEIN

The grain-curd method of making casein was developed in the bureau laboratories and was found entirely suitable for commercial manufacture, and plans were made to introduce it in the casein industry. This fact was announced in a department press release on May 22. Up to the end of the fiscal year letters had been received from 141 persons asking for further information regarding the sub-

ject. Two men were sent to the field to carry on this work, and sufficient progress had been made by the end of the fiscal year to indicate that many manufacturers are going to adopt this method, and thereby make a product of much higher quality and more profitable than in the past.

Samples of casein were obtained from 27 manufacturers in various parts of the country in order to determine the average quality of casein being manufactured. These indicated the need of a better manufacturing method.

THE GROVE CITY CREAMERY

At Grove City, Pa., is a cooperative creamery in which the bureau, by cooperative arrangement, maintains a research laboratory and tries out the results of its research work under commercial factory conditions. The field man at Grove City has been instrumental in having the following improvements made on patrons' farms: Twenty-nine new milk houses built, 8 others improved by installing concrete floors and cooling tanks, and many others improved in minor ways. Concrete floors were laid in 17 barns, swinging stanchions were installed in 9 barns, and many others were improved with windows, tight ceilings, whitewashing, etc. Five silos were built. Four patrons replaced scrub bulls with purebreds, and two of them also purchased registered females for foundation stock. Thirty-eight patrons were assisted in producing milk that would pass the methylene-blue test; 30 of them now pass the test regularly, and the others fail because of lack of cooling facilities.

INSPECTION OF RENOVATED-BUTTER FACTORIES

This work was continued as in previous years. Meat inspectors of the Bureau of Animal Industry made weekly inspection of the renovated-butter factories at St. Paul, Minn., Kansas City, Mo., Topeka, Kans., and Birmingham, Ala. A Bureau of Dairy Industry inspector made monthly inspections of the plant at Middletown, Md. These five factories this year made a total of nearly 2,000,000 pounds of renovated butter, which was about two-thirds of the total quantity made last year.

INFORMATIONAL WORK

L. R. ENDER, *in Charge*

During the year 12 new publications and revisions of existing publications were issued, and manuscripts for 14 additional new publications were submitted for publication. These are both technical and popular in nature. Members of the bureau's staff also contributed to the dairy and general press many articles on their work, and made many addresses at colleges and universities and at meetings of various groups of people interested in the different phases of the dairy industry. Specialists of the bureau delivered many addresses of dairy information over a national chain of radio stations in the course of the year. They contributed a number of articles to The Yearbook of Agriculture for 1930. The bureau cooperated with the office of exhibits in the preparation and display of educational dairy exhibits at expositions, State fairs, etc. The demand

for dairy exhibits is increasing, and comes from all parts of the country. The bureau cooperated with the office of motion pictures in the making of a new educational film on the improvement of the quality of the milk supply, and this film will be released shortly. The educational film "A Tale of Two Bulls," which was first released in October, 1922, continues to be a very popular film. It is estimated that this film has been seen by more than a million people. The film has been shown in practically every important dairy community in the country.

REPORT OF THE CHIEF OF THE BUREAU OF ENTOMOLOGY

UNITED STATES DEPARTMENT OF AGRICULTURE,
BUREAU OF ENTOMOLOGY,
Washington, D. C., September 25, 1930.

SIR: I submit herewith a report of the work of the Bureau of Entomology for the fiscal year ended June 30, 1930.

Respectfully,

C. L. MARLATT,
Entomologist and Chief of Bureau.

Hon. ARTHUR M. HYDE,
Secretary of Agriculture.

INTRODUCTION

The work of the Bureau of Entomology is distributed among the following 10 divisions: Deciduous-Fruit Insects, Cereal and Forage Insects, Truck-Crop Insects, Cotton Insects, Insects Affecting Tropical, Subtropical, and Ornamental Plants, Insects Affecting Forest and Shade Trees, Insects Affecting Stored Products, Insects Affecting Man and Animals, Bee-Culture Investigations, Taxonomy and Interrelations of Insects.

This work is being conducted at 113 different field stations located in 36 States. There are additional stations in Alaska, Hawaii, the Canal Zone, and in seven foreign countries. All but one of the foreign stations are concerned with the collection of parasitic and beneficial insects to be imported into the United States to aid in the biological control of certain recently introduced pests.

The Division of Taxonomy and Interrelations of Insects is concerned with such basic work as the scientific study of insects from the standpoint of determination and classification, and with other related technical investigations. Bee culture represents an important industry and is studied to secure better protection from any preventable hazards—diseases and parasites of bees, winter losses, etc.—and to increase production. The other eight divisions of the bureau cover research in the field of control of important farm, garden, and forest insect pests, and insects having any important economic relationship with man and animals. Much of the work in these several fields of research has to do either with native or long-established insect pests, as to many of the more important subjects, and is maintained from year to year for the purpose of improving methods of control or modifying them to meet new conditions in different sections of the country. The practical results of such continuing

work in this field, while not spectacular or of special news value, nevertheless represent probably the major yearly output of the bureau. New subjects for investigation are, however, constantly arising, concerning either native insects assuming new and harmful relations or recently introduced pests, and these—and particularly the latter—frequently develop perhaps a much larger public interest for the time being and are therefore given special prominence in annual reports.

The annual budget for the bureau reflects increases both as to such old and continuing subjects and new fields of work. As a matter of record, the important increases for the fiscal year under report may be summarized as follows.

NEW SUBJECTS

For importation and establishment of parasites of the oriental fruit moth, \$15,000; for the introduction and establishment in Cuba of black-fly parasites imported from the Orient, in cooperation with the Cuban Department of Agriculture, \$6,000; for investigating the strawberry-root aphid in North Carolina, \$2,000; for the collection near Mexico City of dipterous parasites of the Mexican bean beetle, and for importing and establishing these parasites in this country, \$5,000; for investigating leaf hoppers affecting alfalfa, clover, and other forage legumes, particularly for initiating investigations of the rôle of leaf hoppers in the transmission of alfalfa yellows, \$3,000; for devising methods of disposing of waste from gins and oil mills as a means of preventing the spread of the pink bollworm and *Thurberia* weevil, \$6,000; for the importation and establishment of promising parasites of the pink bollworm recently found in Kenya Colony, East Africa, \$10,000; and for investigations on eye gnats in California, \$12,000. Total, \$59,000.

INCREASES AS TO OLDER OR CONTINUING SUBJECTS

For study of methods of disinfecting imported and domestic nursery stock and other plant products to facilitate insect quarantine operations, \$3,000; for investigating bulb insects in the East, \$7,500; for the investigation of hydrocyanic-acid gas fumigation as a means of controlling scale pests of citrus and other fruits in southern California, \$4,160; for working out methods of control of the wireworms affecting miscellaneous truck crops in Idaho and Washington, \$5,000; for expansion of work on the sugar-beet leaf hopper in Idaho, \$18,000; for expansion of work on the sugar-beet leaf hopper in the intermountain and west coast region, the work centering in the laboratory at Twin Falls, Idaho, \$79,374; for the investigation of tree-killing bark beetles in the Western States, \$9,640; for control of the Mormon cricket in northwestern Colorado, \$8,000; for the importation of parasites of the European corn borer, \$40,000; for investigation of insect pests affecting flour, particularly the flour intended for export, to take care of a serious emergency which has arisen in this field as the result of stringent requirements of foreign importers of flour, \$17,000; and for taxonomic studies of tree-killing bark beetles and weevils injurious to plants and plant products, \$5,000. Total, \$196,674. Total increases, \$255,674.

DECREASES

Gipsy and brown-tail moth project.....	\$1,000 .
Insects affecting cattle.....	100
Bee culture.....	120
<hr/>	
Total decreases.....	1,220
Total net increases.....	254,454

The work, so far as it has been possible to institute it under these new subjects, and also as to old work, will be indicated in the reports under the different divisions concerned.

DECIDUOUS-FRUIT INSECTS

Investigations of deciduous-fruit insects have been carried out, as heretofore, under the direction of A. L. Quaintance.

• JAPANESE BEETLE

General summer scouting as well as quantitative larval surveys conducted in certain selected areas during 1929 served to confirm the earlier-expressed opinion that the Japanese beetle is decreasing in the older occupied areas and increasing in those more recently invaded. The decrease in 1929 in the Moorestown-Riverton district reached a point which caused repeated inquiries to be made by the citizens as to what had become of the beetles. In localities more remote from the original center of spread, on the other hand, the infestation in 1929 increased to proportions comparable to conditions which existed in the Riverton area during the period 1920 to 1925.

This belief was further confirmed by extended larval scouting during the season of 1930. In connection with the surveys it has been observed that in rolling country larvae are likely to be much more abundant in low-lying, poorly drained situations, a fact of which advantage may be taken in control operations.

BIOLOGY

As during earlier years, information on questions relating to the biology and behavior of the beetle in its various stages is being secured and utilized wherever possible in repressive work. Recent studies indicate that pupation is either completely inhibited or excessively prolonged when temperatures fail to reach 65° F., no matter how far advanced the larvae may be at the time of entering winter hibernation. Studies have been made as to the time required for the development of the egg and pupa under variable temperatures as compared with constant temperatures. The results indicate that, within the limits of experimental error, the time required for development under a set of variable temperatures will fall close to, or coincide with, the time taken at a constant temperature coinciding with the mean of the variable temperatures. However, this general rule was found to apply only in those cases where the range of the variable temperatures lay above the temperature where development begins. In view of the fact that by far the greater part of the life cycle of the Japanese beetle is spent in the soil, the studies in the correlation of atmospheric and soil temperatures have been stressed as in previous years. These data may be useful in computing the time of

appearance of the successive stages of the insect for different soils and for different parts of the country. Thus, based on the knowledge that pupation does not ordinarily take place until a temperature of about 65° is reached, maps were drawn showing the zone within which the beetles, if established, would probably first put in appearance. During the spring of 1930 these maps were utilized by the scouting service of the Plant Quarantine and Control Administration, and to date the results are in fairly close agreement with those anticipated.

SOIL-INSECTICIDE INVESTIGATIONS

During the fiscal year research work in this field has been carried on largely with a view to developing new methods and improving existing procedures for destroying the immature stages of the Japanese beetle in the soil about the roots of many different kinds of nursery plants. The experimental work to determine the efficiency of immersing the subterranean portion of dormant nursery plants in water at a temperature of 112° F., to destroy the immature stages of the beetle, has been practically completed, and it is now possible to recommend the treatment as a quick, simple, and effective method for use in the case of certain herbaceous plants and deciduous shrubs. It has been successfully demonstrated that 3-year-old plants of *Azalea indica* can be fumigated with carbon disulphide. The plants are put in a special fumigating tank in such a manner that the top is protected from the gas by being immersed in water while the roots are exposed to the insecticidal vapor. Experiments are under way to determine the optimum dosage, temperature, and period of exposure to insure the destruction of the insect. Attention is also being given to the penetration of the gas in soils of different types and with varying degrees of moisture, and the effect of the treatment on the azaleas at different seasons of the year.

Extensive experiments have been carried on with stomach poisons for destroying the larvae of the beetle in the soil. The insecticidal action of a stomach poison in the soil is the complex resultant which depends upon the interaction of the soil and the chemical and the degree of activity of the insect. Considerable information has been obtained on the use of lead arsenate and other stomach poisons in the soil, but the knowledge of the action of these materials on the soil, on the plants, and on the insects themselves is far from complete.

Lead arsenate is now recommended to control the larvae of the beetle in lawns and golf greens, but experiments are under way with 560 plots of grass which have been treated with different doses of lead arsenate and different fertilizers, and planted with seven different commercial grasses, in order to obtain further information on the effects of the different treatments on the turf, and the effectiveness of the different treatments in protecting the turf from grub injury.

Extensive experimental work is being conducted with the arsenates, borates, and fluosilicates in the soil in the greenhouse and in 1,050 specially constructed cages in the field, to determine the relative effectiveness of the different materials in destroying the larvae of the beetle in different soils, the period of time that soils treated with

the different materials will remain toxic to the larvae, and the effect of the different treatments on plants growing in the soil.

On the basis of the experimental results obtained thus far, lead arsenate has been recommended and has been used successfully on the whole in the treatment of over 1,200,000 square feet of soil about the roots of 316,000 evergreen and deciduous plants in commercial nurseries to destroy the larvae of the beetle. A group of evergreen and deciduous plants representative of the types handled by the commercial nurseries is now being grown in the laboratory nursery in soil poisoned with lead arsenate.

It was early realized that in order to continue the use of lead arsenate as a treatment for the soil about the roots of growing nursery stock it was necessary to develop a method of determining by chemical analysis the thoroughness of the application and the concentration of the poison in the soil. A method for analyzing the soil has been developed, so it is possible to maintain the proper insecticidal concentration of the poison in the soil and to avoid causing excess injury to the plants. During the spring of 1930 over a thousand samples of poisoned soils were taken from the experimental nurseries or from commercial nurseries and examined by this procedure.

BEETLE-INSECTICIDE INVESTIGATIONS

As a result of studies made with limes and other inorganic white materials as repellents for the beetle, it was found that zinc oxide, basic lead carbonate, zinc sulphide, and titanium dioxide were promising. Among the volatile materials which have shown indications of being repellent to the beetle are pine-tar oil, bone oil, and chloronaphthalene. Effort is now being made to prepare fractions of these oils applicable for beetle control under conditions in which it is impossible to use a poisonous material.

In an experiment with 500 traps carried out during the summer of 1929 on a 15-acre lawn 1,876 pounds of beetles (approximately 10,000,000 individuals) were captured. A survey of the soil of this area showed many millions of larvae which were later poisoned with lead arsenate. A new bait for the traps, in which the geraniol and eugenol content has been increased, has captured over two and one-half times as many beetles as did traps containing bait prepared in accordance with previous recommendations.

THE ESTABLISHED FLY PARASITES

The parasite *Centeter cinerea* Aldrich has now spread over some 90 square miles. In 1929 five additional colonies of this parasite were started in the heavily infested areas surrounding Philadelphia. Single colonies were also placed at Harrisburg, Pa., and Stamford, Conn. Checks on these colonies show that establishment occurred in almost all cases, including Harrisburg. The value of this species as a controlling influence on the Japanese beetle is not certain, as its habits and biological development are not well synchronized with the appearance of its host in this latitude.

Prosema siberita Fab. is established in the Moorestown district, but as yet is too sparsely distributed to effect a notable parasitism of the Japanese beetle larvae. Observations made in 1929, however, indicate considerable increase in numbers as compared with the year previous. This species, which is dependent on late-maturing larvae, has not met optimum conditions in New Jersey, and as a consequence two new colonies were started in areas in Pennsylvania where late-maturing host larvae are more abundant.

Dexia ventralis Aldrich, like the preceding species, has not met favorable conditions in the Philadelphia district. Unfortunately, no increase has been noted in the colony established in New Jersey during 1929. Since late-appearing host larvae are necessary for its success, advantage has been taken of the topography of Pennsylvania and a more favorable habitat has been selected. This latter point has not yet been reexamined since liberations were made there.

THE ESTABLISHED WASPLIKE PARASITES

Tiphia popilliavora Rohwer is well established in a large mother colony about $3\frac{1}{2}$ square miles in area. In August, 1929, 10,100 females were collected from this colony and used to establish 101 other colonies in infested areas in New Jersey and Pennsylvania. Recoveries from former colonies started in similar fashion have been most encouraging, showing that the species is readily established when units of 100 females are placed under favorable conditions. To date this species has been liberated in 145 localities.

Tiphia vernalis Rohwer, which has been recovered from the several points of liberation in previous years, has shown a marked increase in numbers in two localities, namely, Philmont, Pa., and Medford, N. J. The indications given by the 1930 scouting are that the Philmont colony will perhaps be large enough next season to permit of subcolonization from that center. In addition to the colonies of this species from which recoveries have been made, seven new colonies with about 6,000 imported females were started this spring. One such colony is located on Long Island, N. Y., making the total number of localities for the species 19.

THE FOREIGN PARASITE WORK

Parasite material has been received in large lots and in good condition from Japan. Continued introductions are planned for certain species. It is essential, however, that considerable research be conducted to determine a number of points concerning the species which have not yet been successfully introduced, to ascertain, if possible, why failure has occurred. This research should also include studies of certain rare species in order to ascertain if they are more abundant in localities hitherto unexplored. It is felt that one man, free from other responsibilities, should be assigned to this work.

MISCELLANEOUS INSECTICIDES

Investigations of the more fundamental questions relating to insecticides have been continued in the laboratory in Washington and at the field station at Sligo, Md., certain phases of these investigations having been carried on in cooperation with the Bureau of

Chemistry and Soils. In April, 1930, a commodious laboratory building was rented at Takoma Park, Md., which has been equipped for various kinds of work relating to problems of insect toxicology and physiology as well as other special studies. The force in Washington has been moved to this new station, and the personnel at the Sligo laboratory has been transferred to the new quarters.

During 1930 a comparison was made of four methods of determining the relative toxicity of stomach-poison insecticides, the compounds used being acid lead arsenate and sodium fluosilicate. A total of 32 stomach poisons were investigated by the "sandwich method" as to their relative toxicity. Only two of these materials, manganese arsenate and p-nitrosodium-ethylalanine, appear to deserve further study. Some time has been given to developing a sensitive electroscope for the measurement of minute quantities of thorium B. This instrument is now being used for determining the distribution of lead in insects. Studies of the toxicity of rotenone as a contact insecticide are under way. Information has been obtained about its toxicity relative to that of nicotine, the effect of spreaders on its toxicity, the effect of hydrogen-ion concentration on its toxicity, and the change during storage in the toxicity of sprays containing it. Studies in the tropisms and behavior of insects have been continued. A paper has been submitted for publication on the tropisms and sense organs of the Coleoptera, which is a companion paper to the one already issued on tropisms and sense organs of the Lepidoptera. In the search for attractants and repellents, an improved feeding method was devised and used to determine whether bean beetles (the insect used on account of its availability) like or dislike the four classes of substances that produce the four human attributes of taste. It was found that they disliked water containing salts, acids, bitter materials, and saccharine. However, they liked other sweet substances tested, such as cane and grape sugars, and different forms of molasses. Bean foliage sprayed with arsenicals was repellent but not sufficiently so to prevent its being eaten. Lead arsenate was most repellent; magnesium arsenate was less so, and calcium arsenate least repellent.

In connection with the determination of what injury, if any, would result to peach trees from repeated annual use during the dormant season of lubricating-oil emulsions, the eighth annual oil treatment was given to trees during the winter of 1929-30. No injury was apparent to trees after eight years of treatment with 3 per cent oil emulsion, and this test has therefore been concluded. Emulsions of 3, 6, 12, 15, and 25 per cent of oil have been used on peach trees during the dormant season for three years past, and considerable injury from the 15 and 25 per cent emulsions has been noted. A 10 per cent emulsion was again used on a block of trees which received the same treatment last year, with no cumulative effect. A test of paradichlorobenzene in 1 and 1½ per cent lubricating-oil emulsions as a treatment for the San José scale gave no better results than the use of emulsions alone.

Further experiments in the development of a cold-stirred lubricating-oil emulsion, in which potash rosin fish-oil soap was used as an emulsifier, confirmed previous experience with this spray for dormant and delayed dormant use, especially for the San José scale and

spider mites. The advantages of this type of emulsion are that it will mix readily with most hard waters. It has a higher oil content and lower freezing point and requires less costly equipment in its preparation. Instructions for making the emulsion were given in a special mimeographed circular (E-277).

Dormant-spray experiments with lubricating-oil emulsions at Yakima, Wash., during 1929-30 have shown that winter-strength oils applied before the middle of March do not appreciably affect the set of fruit, but that when applied later than this the set of fruit is smaller than on trees sprayed with lime-sulphur wash or on trees not sprayed at all. The results indicate that an oil with a sulphonation test of 65 is safer than one with a sulphonation test of 50; in other words, the more highly refined oil is the safer.

PLANT DISINFECTION

In connection with studies of the action of the high-frequency electrostatic field on insects, it was found that a field having a frequency of 25 meters and a flow of 4 to 6 amperes killed insects only on long exposure, but it killed or seriously injured growing plants within a few minutes. The electrostatic field apparently affects the organism by heating the tissues to a high temperature. Experiments with hot water as a treatment for fruit stock infested with the oyster-shell scale or with the San José scale indicate that the former species can be destroyed by immersion in water at 112° F. for 30 minutes or in water at 120° for 20 minutes. The San José scale was not killed by the treatment at 112° but was destroyed at 120°. Apple, peach, and pear stocks were immersed successfully while dormant for periods of time sufficient to kill insects, but plum, quince, and cherry stocks were severely damaged by the treatment.

A method of treating baskets of fresh blackberries, raspberries, strawberries, gooseberries, currants, blueberries, and peaches to destroy the Japanese beetle and certain other insects has been developed, and was used successfully in the treatment of several thousand baskets of fresh fruit during the season of 1929. The fruit was subjected to a fumigation with carbon disulphide in the proportion of 10 pounds to 1,000 cubic feet for a period of two hours, at a temperature of 80° F. This treatment was fatal to the insects exposed, without appreciable detrimental effect on the appearance, edibility, or keeping qualities of the different fruits.

NUT INSECTS

The bureau has been represented on the department pecan committee which was organized by the Director of Scientific Research for the purpose of coordinating all of the department's investigations dealing with the pecan industry. Partly as a result of the activities of this committee the chamber of commerce at Albany, Ga., has provided the Department of Agriculture with a large laboratory building for the use of the various department investigators who are working on the pecan in that district. This building, which was practically ready for occupancy on June 30, will provide working space for representatives of the Bureaus of Plant Industry and Chemistry and Soils, as well as for the Bureau of Entomology. A much better coordination of the work of the various agencies is certain to result.

PECAN NUT CASE-BEARER

The damage caused by the pecan nut case-bearer is particularly conspicuous during years when the nut crop is unusually short, and this has been the case during the crop season of 1930. In the eastern part of the country, however, this insect is not regularly seriously injurious. For several years records have been made of the extent of nut case-bearer infestation during the course of record taking of experimental spraying operations. Thus in one grove, in 1926, of 174,255 nuts examined, 1.4 per cent were infested. In another grove during the same year it was found that of 42,633 nuts examined, 2.17 per cent showed injury. Of 58,396 nuts examined in 1927, 0.5 per cent were infested, and in 1929, 3.44 per cent of infested nuts were found in 137,871 examined. During the years 1926 to 1929 the infestation for southern Georgia as a whole averaged well under 10 per cent.

Extended information on the biology of the nut case-bearer has now been obtained, though there are numerous points still requiring study. Much experimentation has been done in groves in spraying and dusting with arsenicals and other insecticides. The tenderness of the foliage of the pecan to arsenicals greatly limits the dosage and number of sprayings that may be given, and to date no arsenical has been found which at the same time is noninjurious to foliage and effective on the insect. In the hope that a detailed study under controlled conditions in the laboratory would disclose some point in the behavior and feeding habits of newly hatched larvae of which advantage could be taken in orchards, much time during the fiscal year was given to such investigations. However, no important new leads were found.

At the Brownwood, Tex., station, where the pecan growth is still largely that occurring in river bottoms and is often of considerable size, special attention has been given to the possible utilization of parasites for the nut case-bearer, as well as for other pecan insects. The egg parasite *Trichogramma minutum* Riley is being reared in fairly large numbers and has been found to parasitize freely the eggs of this insect in the field. Investigations are under way with another parasite of this case-bearer and also of the shuck worm, namely, *Perisierola cellularia* var. *punctaticeps* Kieffer, and methods have been devised to propagate it. With the present limited facilities, some 25,000 individuals were bred and liberated during the season 1929. In the southeastern part of the pecan belt, with headquarters at Albany, Ga., parasites of the case-bearer have been under inquiry for some years. In view of the difficulty and expense involved in the use of sprays in pecan orchards, it is felt that every effort should be made to utilize the natural enemies of these pests to the fullest extent possible. Special attention will be devoted to *Trichogramma minutum*, and it is expected that this egg parasite can be produced in large numbers for liberation another season. If it is found that this egg parasite or other parasites can be propagated and liberated in a way to reduce the damage materially, it is expected that the actual work of supplying these beneficial forms to growers will be undertaken by the interested States or by commercial interests.

PECAN SHUCK WORM

Much additional information has been accumulated during the year on the biology and parasites of the pecan shuck worm, which ranks probably second in importance to the nut case-bearer. It likewise has not proved to be controllable to any extent by the usual insecticides sprayed or dusted on trees. It can, however, be very materially reduced in numbers in groves if careful attention is given to collecting and destroying all pecan shucks or hulls which are on the ground or elsewhere after harvest, since it is mostly in these that the insect passes the winter. Several of the parasites attacking the nut case-bearer have been reared from the shuck worm. It is thus possible to utilize certain parasites for the control of both species, and owing to certain differences in the life history of the pests involved the welfare of the parasites will be favored rather than otherwise.

PECAN LEAF CASE-BEARER

During 1929 experiments were conducted in two pecan groves in the vicinity of Albany, Ga., to determine (1) the relative effects of Bordeaux mixture and hydrated lime as correctives of arsenical injury to pecan foliage, and (2) whether an arsenical cheaper than lead arsenate could be used with Bordeaux mixture for the control of this insect.

As to the first point, it was found that acid lead arsenate and hydrated lime and acid lead arsenate, hydrated lime, and fish oil caused considerable burning to foliage and partial defoliation of the trees, the damage being a little more pronounced where fish oil was used. On the plots where a combination of lead arsenate and Bordeaux mixture, of the formula copper sulphate three-fourths of a pound, hydrated lime $1\frac{1}{4}$ pounds, water 50 gallons, was employed there was slight foliage injury, but when the strength of the Bordeaux mixture was increased to copper sulphate $1\frac{1}{2}$ pounds, hydrated lime $2\frac{1}{2}$ pounds, water 50 gallons no injury resulted. On other plots where Bordeaux mixture of the formula copper sulphate 3 pounds, lime 5 pounds, water 50 gallons was used with calcium arsenate and Paris green no foliage injury or defoliation occurred. Since the calcium arsenate is materially cheaper than Paris green or lead arsenate, it would appear that this arsenical may be used in the foregoing formula of Bordeaux mixture with safety and advantage, since applications of a combined fungicide and insecticide are frequently desirable as a simultaneous treatment for fungous diseases and insects. Furthermore, it was ascertained that calcium arsenate, pound for pound, is rather more effective than lead arsenate and that Paris green was almost equally so. The addition of fish oil to the Bordeaux mixture-calcium arsenate spray did not materially add to its effectiveness.

BLACK PECAN APHID

The black pecan aphid (*Myzocallis fumipennellus* Fitch) is proving to be a serious pecan pest because of the defoliation of the trees, occurring principally during the summer as a result of its feeding. This injury is followed the next season by a light setting of nuts. Thorough tests have been made of the delayed dormant sprays,

which are usually successful in the control of aphids affecting apple and other deciduous fruits, but none of these has given satisfactory control of the black pecan aphid, perhaps because the eggs, which hatch rather late in the spring, are laid in crevices in the rough bark on the larger branches of the tree. The use of nicotine sulphate with the regular Bordeaux sprays was found to give a degree of control, but treatment of large pecan trees with nicotine sulphate is extremely expensive and is not being practiced by growers.

Biological studies of the black pecan aphid have been made at the Albany, Ga., and Experiment, Ga., laboratories, and considerable attention has been devoted to the relationships of the various parasites of this aphid to other hosts which may be present in close proximity to pecan orchards.

OBSCURE SCALE

A major project of the Shreveport, La., laboratory has been the study of the obscure scale (*Chrysomphalus obscurus* Comst.), a species concerning which not very much has been known, and rather comprehensive biological studies have been made. This scale, which attacks the pecan, seems to be a slow-growing insect and develops only a single generation a year. Tests of lime-sulphur and of various oil sprays have demonstrated that it is not satisfactorily controlled by any of the dormant applications which have been found effective against many other diaspine scales. The reason for this has not yet been determined, though it was noted that the wax covering of the insect is comparatively dense.

CHESTNUT WEEVILS

Chestnut weevils have continued to be the major problem at the laboratory at French Creek, W. Va. As indicated in previous reports, these weevils constitute the limiting factor in the development of a blight-resistant variety of chestnut to replace the native nuts. A practical method of controlling these weevils, based upon recent experiences, appears to be in sight. The treatment consists of applying to the trees a heavy whitewash of hydrated lime. This acts as a repellent of the weevils and thus materially reduces the oviposition in the chestnut burrs. At Bell, Md., 300 nuts from whitewashed trees yielded three weevils, whereas a similar number of nuts from untreated trees yielded 145 weevils. At French Creek, W. Va., 75 per cent of the nuts from treated trees were sound as against 33 per cent sound from untreated trees. Favorable results have also been obtained by treatments of the soil with carbon disulphide and with ethylene bromide for the destruction of the grubs therein.

PEACH INSECTS

PLUM CURCULIO

An unusually serious situation developed in regard to certain peach insects during the season of 1929. The plum curculio, always present in orchards, was extremely abundant and destructive, and the spread and increase of the recently introduced oriental fruit moth added very materially to the damage, especially in certain

districts. In planning the work on peach insects, beginning with the spring of 1930, it was determined to recheck the earlier results as to the effectiveness of various treatments for the curculio on peach and to develop, if possible, supplementary control measures. This work was inaugurated at the Fort Valley, Ga., laboratory.

Both in the laboratory and in the field a number of poisons other than lead arsenate have been under test for some seasons. This work was continued during the present fiscal year. The problem is to find a material that is poisonous to the curculio but does not injure the foliage and fruit. The almost invariable injury to peach foliage from lead arsenate, the best poison now available, greatly limits the degree of curculio control which otherwise could be obtained by spraying. Of the materials under experiment potassium fluosilicate appears to be a very promising substitute. Following laboratory tests and small-orchard experiments, larger-scale work was undertaken in the spring of 1930. Elberta trees were given four applications of potassium fluosilicate, 2 pounds to 50 gallons, without lime, the last two applications being applied in a fungicide on some of the trees. There was no fruit injury whatever and practically no injury to the foliage. From this one year's orchard test potassium fluosilicate, without lime, appears to be a safer insecticide on peach than lead arsenate. The fact that lime contributes to injury from this material, however, complicates the use of sulphur-lime fungicide for peach diseases.

Probably the most important supplementary measure in curculio control is to gather from the ground under the trees the many peaches which fall early in the season because of curculio punctures, and those which are thrown off by the tree as the so-called "June drop." A considerable percentage of these drop fruits contains grubs of the curculio, which when grown will desert the fruit and burrow into the soil to complete their transformation to adult beetles. Gathering drops has been urged by the bureau for a number of years, and the practice is growing in favor among orchardists. The best way to dispose of these drops, which often accumulate in large numbers, to insure destruction of the contained grubs, has been studied during the year. A number of materials have been used in an experimental way in trays and containers to simulate conditions of the soil under the trees. Paradichlorobenzene, emulsified in mineral oil and sprayed on the drops, gave the best results and appears promising for the purpose. Experiments are in progress to determine the effect on the grubs in peaches of exposing the fruit in the middle of tree rows to the intense heat of the sun on the surface of the soil. No insects whatever have emerged to date from the drop peaches thus exposed, whereas emergence of the beetles from similar lots of drops kept in the shade has been about normal. Tests are under way with carbon disulphide, paradichlorobenzene, and other materials for the destruction of grubs and pupae in the soil after they have escaped from the drop peaches under the trees, to supplement the work of gathering drops and thus further reduce the beetle population in orchards. Tests have also been made to determine how deep in the soil it is necessary to bury drop peaches to prevent the escape later of the developed adults. Beetles have been noted to emerge from drops covered with soil to a depth of 18 inches, which is the maximum depth tested.

The infestation of southern peach orchards by the plum curculio during 1929 was the heaviest since 1921, and the loss from the insect amounted to many millions of dollars. To avoid a repetition of this in 1930, a curculio-suppression campaign was inaugurated in January through the delivery of lectures before various southern horticultural societies, through meetings with State extension agencies, the distribution of publications, and otherwise. The growers themselves cooperated heartily in this effort by giving unusual attention to the operations necessary; namely, spraying and dusting at the proper season, the picking up of drop peaches, the use of curculio catchers, etc. The insects did not begin to leave hibernation in the Georgia peach belt until about the middle of March. This date was so late that it was believed that injury from second-generation curculios would be unimportant, and subsequently this belief proved to be correct. As a result of the campaign, aided greatly by favorable weather, the peach growers of the South marketed a crop of unusually good quality.

ORIENTAL FRUIT MOTH

The oriental fruit moth has now invaded practically all important peach-growing districts east of the Rocky Mountains from Canada to Georgia. Its injury during 1929, especially in the more recently invaded districts, was severe and was the cause of much complaint from growers. For several years the bureau has been continuously engaged in investigations of this insect, principally with headquarters in New Jersey and Georgia and, more recently, in Indiana, in co-operation with the Indiana Agricultural Experiment Station, and much has been learned about its biology and habits. The larva, which is the damaging stage, attacks a wide variety of fruits, and the insect is now recognized as an important apple pest. The habits of the larva on peach are such that it is not amenable to control by the usual spray applications of arsenicals or other stomach poisons. Experiments thus far have not developed a satisfactory method of treatment, despite the extensive work which has been and is being done by State and Federal workers.

One of the hopeful methods of control, as indicated by rather limited experiments, is the employment of so-called bait traps. These involve the exposure in containers in the tree tops of fermenting molasses, fruit juices, and similar materials to attract and trap the moths. The results in southern Indiana during 1929 so impressed a number of fruit growers that funds were made available by Congress in the first deficiency act to inaugurate two large-scale experiments in bait trapping and to enlarge the research work under way. This bait work, begun in the spring of 1930, is located in two important fruit districts, namely, in northern Georgia, with headquarters at Cornelia, and in southern Indiana, with headquarters at Vincennes. In each location approximately 500 acres of orchard are under experiment, and each tree in the orchard is supplied with a bait trap, there being about 50,000 traps for each area. The severity of the winter of 1929-30 greatly injured peach trees in the Vincennes district, so conditions for the experiment at that place were far from ideal. Some data, however, can be secured with reference to the peach, and, more especially, the apple, which in this district is an important crop. Conditions for the work are much more favorable

in the northern Georgia district, but the insect has not been so abundant during 1930 as it was during the preceding year. These large-scale experiments, eliminating the effect of migration of the insect, should show, when the results for the season are tabulated, what may be expected when bait work is carried out by orchardists in a thoroughgoing and cooperative manner. Many interesting facts are being determined concerning the reaction of the insect to different baits, its movement in orchards, etc.

In view of the ineffectiveness against the fruit moth thus far of the usual methods of control, special attention is being given to the possible utilization of its natural enemies. Since the insect made its way to North America, about 1910 or 1911, it has been attacked by a surprisingly large number of native parasites, a few of which are proving important. Careful studies of the biology of two parasitic insects have been made and are in course of publication. An increase in funds in the first deficiency act permitted material enlargement of this work. Arrangements have been made for the propagation and liberation in large numbers of two or three of the more promising parasites. During 1929 fair success was obtained in breeding in quantity *Macrocentrus ancylovora* Rohwer, by far the most important indigenous species to date. In addition to the fruit moth, this parasite attacks the strawberry leaf roller (*Ancyliis comptana* Froel.). As a host, the latter is more easily handled in the laboratory than is the former, but there are only three broods yearly, and it is more susceptible to disease in confinement. Peach twigs, up to the time they begin to harden, provide the best medium for the fruit moth larva, after which cut apples can be utilized with fair success. With this parasite it was possible to obtain from 70 to 80 per cent parasitism of host larvae, but about 50 per cent was all that could be reared to the cocoon stage. It appears that successful mass production of *M. ancylovora* will be possible if the question of host larvae can be satisfactorily met. In the spring of 1930 some 55,000 peach twigs infested by first-brood fruit moth larvae and 210,000 first-brood strawberry leaf rollers were collected. These collections have been supplemented by the exposure of several thousand larvae to the parasite in captivity. (*M. ancylovora* was emerging by July 1, 1930, at the rate of about 1,500 per day, a total of 28,000 having emerged.) Thus far 68 colonies have already been distributed in Connecticut, Pennsylvania, Ohio, Indiana, Illinois, Kentucky, North Carolina, South Carolina, and Georgia. A total for the season of about 35,000 individuals of this species is expected. Several of the States, as well as Canada, have been collecting parasites in New Jersey, and in this work the Bureau of Entomology and the New Jersey Agricultural Experiment Station have cooperated. A total of 109,000 infested peach twigs and 270,000 strawberry leaf rollers have thus been obtained for use in the States mentioned.

Other parasites than *M. ancylovora* are receiving attention. *M. delicatus* Cress., it has been found, can be propagated about as easily as its cogener. *Ascogaster carpocapsae* Vier. and *Phanerotoma tibialis* Hald. can also be produced in large numbers. *Glypta rufiscutellaris* Cress. develops readily on fruit-moth larvae, fed on thin slices of apple. The effort to produce *Trichogramma minutum* for preliminary studies in connection with mass liberation indicates a need for special equipment, especially to effect the control of a mite

which becomes abundant in the corn used for developing the host moth as a source of eggs for the parasite. The experience gained will doubtless indicate methods of breeding the parasite for experimental midsummer liberation, especially designed to control the fruit moth on mid-season and later peaches.

Ecological studies of the oriental fruit moth were made during the spring of 1930 and include a regional survey as to parasites attacking the pest, the determination of the rôle of the strawberry leaf roller as a host outside of New Jersey, dissemination studies, and a study of alternate host relationships and of the relation of the insect to hosts other than peach. This work, it is believed, will develop important information, but sufficient results have not thus far been secured to warrant particular mention.

The activities of the fruit moth in the middle Georgia peach belt are less at present than at any time since its establishment in that district. During the course of orchard experiments for the curculio and the fruit moth many thousands of peaches have been examined in which infestation did not average in excess of 1 per cent. These data serve to confirm earlier observations indicating that the insect will not be a factor of importance in the middle Georgia peach belt because of the time of harvest of the principal varieties of peaches grown.

LESSER PEACH BORER

Further tests of the paradichlorobenzene-cottonseed oil wash as a paint for areas on the trunks of peach trees infested with the lesser peach borer confirm earlier results as to the effectiveness of this combination. A practical treatment for this borer, frequently important in southern orchards, has thus been found and its value demonstrated. It can doubtless be used on a considerable number of insects infesting the bark of various shade and other trees. A public-service patent covering this discovery has been applied for.

GRAPE BERRY MOTH

Work with grape insects has been mostly limited to field experiments in the control of the grape-berry moth in cooperation, as formerly, with the Ohio Agricultural Experiment Station, with headquarters at Sandusky, Ohio. Because of the severity of infestation by this insect in vineyards in the northern Ohio grape belt and the corresponding necessity for thorough and late spraying, the arsenical residues on harvested fruit, resulting from the spray schedules employed, have been seriously objectionable. Continued effort has, therefore, been made during the year to determine what changes in the schedule and spraying materials would meet the situation. It now seems clear from extensive tests that the grape-berry moth can not be controlled on grapes with lead arsenate without leaving an excess of poison on the ripe fruit. This is due to the necessity of applications in late July and August for the second and very damaging brood. Other spray materials for late treatments must, therefore, be found, and use made of all possible supplemental measures of control. A large number of arsenicals have been tested as substitutes for lead arsenate, but all of these when employed at sufficient strength and with sufficient frequency to effect control have left objectionable quantities of poison on the ripe grapes. Tests of

numerous other materials, especially for the late application for the second brood, have involved several plant extracts, as commercial Derris extract, 1 to 800, commercial Pyrethrum extract, 1 to 400, and nicotine sulphate, 1 to 800, with 1 per cent commercial white-oil emulsion. Results have varied greatly, some of the materials showing a distinct gain in percentage of sound fruit as compared with plats in which a late spray of lead arsenate was omitted. In none of these materials, however, has there resulted uniformly a control comparable to that obtained from lead arsenate. Special tests are under way with rotenone and with several of the fluoaluminates, as well as other compounds of fluorine, in cooperation with the Bureau of Chemistry and Soils. Some of these fluorine compounds are apparently not seriously injurious to grape foliage, and it is hoped that they may have worth-while insecticidal qualities.

Various adhesives and spreaders for sprays have given good results. Thus fish oil combined with a readily available commercial product gives a much more even coating of the spray material over grape berries than can be obtained with either resin fish-oil soap or fish oil alone. Furthermore, the clotting of spray materials resulting from the spray mentioned is found to be greatly decreased and there is a better penetration of the grape cluster by the spray. A manuscript giving detailed results of tests over the past several seasons is in the course of preparation.

In connection with experiments during the past two seasons to determine possible changes in the time to make spray applications it was found that a preblossom spray did not materially increase control of the first brood of berry worms. If the spray is applied directly after the blossom period, however, and repeated about one week later results are decidedly better than those obtained by applying the first spray about five days after blossom and the second some three weeks later, as is the present rather general practice.

CULTURAL METHODS OF CONTROL

Special attention is being given in vineyards to cultural methods of reducing berry-moth abundance and avoiding the necessity of late spray applications. During the year it was found that in the heavier soils a large proportion of the adults of the grape berry moth were unable to emerge successfully from a covering secured by the usual plowing or disking toward or away from the vines. The plan of work under way to further test the value of disking and concentrated first-brood spraying on a large scale in vineyards is indicated below:

(1) Concentration of spraying against the first brood of berry worms. This includes two spray applications within a 10-day period after the falling of bloom. Later sprays with materials likely to leave excessive arsenic residue to be omitted. Sprays against the second brood limited to nonarsenical materials.

(2) Plowing or disking toward the vines during midsummer, leaving the ground under the trellis in condition for the winter. This cultivation to be given before heaviest emergence of moths from the first brood has taken place, to bury any of the pupae in cocoons

which may have fallen from the grape leaves before emergence, and before cocoons of the overwintering brood are formed, so that these may be exposed on the surface of the ground during the winter.

(3) The ground so treated to be left undisturbed until the following spring in order to avoid giving protection to the overwintering cocoons from the second brood which are on the surface of the ground under the trellis.

(4) Finally, the ground to be thrown away from the vines in the spring, as is the usual practice; this to be finished before the blooming period of grapes, which is the period of heaviest emergence of the moths from the overwintering brood. This covers cocoons which have been present on the surface during the winter, and prevents to a large extent the emergence of moths in early summer.

CODLING MOTH

INSECTICIDES

Because of the spray-residue situation as a result of spraying apples for the codling moth, it has been necessary to continue experiments in the laboratory and field with possible substitutes for arsenical sprays. With the progressive reduction of the quantity of arsenic permitted on harvested fruit entering interstate commerce, the problem of combating the codling moth with arsenical sprays becomes more and more acute and brings in apple-growing regions which otherwise would scarcely be involved. Fortunately, the washing of fruit with dilute hydrochloric acid, with subsequent rinsing with water, has been developed to a very practical degree, and is already in large use in the arid apple-growing districts and will doubtless be followed in numerous apple districts of the East wherever late broods of the codling moth are troublesome. There is none the less urgent need of insecticides which are unobjectionable from the residue standpoint, not only for fruits but for many other plants used in the fresh state as food.

As indicated in previous reports, several fluorine compounds have been under test. While the materials of this group have proved inadequate in the humid portions of the country, several have been found to be nearly equivalent in effectiveness to lead arsenate in the arid sections of the Northwest. The most promising of these at present appear to be cryolite (a double fluoride of sodium and aluminum) and the fluosilicates of potassium and barium. Two applications early in the season of lead arsenate, followed by applications of cryolite, according to the regularly recommended spray schedule, resulted, in the experiments at Yakima, Wash., in better control of the codling moth than was obtained with lead arsenate, and very little arsenical residue was found on the fruit at harvest time. No foliage injury resulted in the Northwest from the use of any of the fluorine compounds under test. Cuprous cyanide has given fairly satisfactory control of the codling moth, although the results have been poorer than those obtained with the fluorine compounds. Tests

are being made at Bentonville, Ark., of manganese arsenate, which has been reported to be a fairly satisfactory substitute for lead arsenate, its chief advantage being in the elimination of lead, which is considered equally or even more objectionable than the arsenic.

The combination of nicotine sulphate with weak white-oil emulsions has continued to give very encouraging results in the tests conducted in the Northwest and at Wichita, Kans. In the Northwest, where practically no rain falls during the growing season, this combination has proved equal in effectiveness to lead arsenate, compared application for application. In Kansas, during an unusually dry season, this combination was nearly as satisfactory as lead arsenate. There is still some doubt as to how practical such combinations will be in portions of the country in which heavy rains frequently occur during the growing season. The combination oil-nicotine spray is more expensive than lead arsenate, but in addition to controlling the codling moth it reduces the percentage of sting injuries much more than does lead arsenate, and also has an important value in the control of various soft-bodied insects, such as leaf hoppers and spider mites.

Tests on a field scale of combinations of white-oil emulsion at low strength with Pyrethrum extract and with Derris extract, as well as tests of nicotine tannate, are being conducted at Yakima, Wash., Bentonville, Ark., and Wichita, Kans., and laboratory studies of the same and other materials are under way at Vincennes, Ind. Rote none, one of the more active ingredients of Derris, is being tested in the laboratory and on a limited scale in the field. Some difficulties have been experienced in devising means of diluting rotenone for application, but it is hoped that these will be overcome. All of these combinations, if found effective, will have their chief use for the second and later broods of the codling moth, since the early applications of lead arsenate against the first brood in most parts of the country do not result in excessive residue at harvest time. In the Northwest, however, the lead-arsenate schedule can not be continued after the first cover spray against the first brood without causing excessive residue.

Studies are under way of various penetrating oils that may possibly be used against the hibernating larvae in order to reduce the population which carries over winter on the trees to start the infestation another season.

Chemically treated bands have continued to give good results. For instance, in one test conducted in the Northwest, nine bands treated with beta-naphthol, oil, and aluminum stearate gave a catch of 4,991 larvae and only three individuals succeeded in reaching the adult stage. Aluminum stearate has been found to be of value as a binder and absorbent for the beta-naphthol and oil, increasing somewhat the efficiency of the bands. Tests in which a half of each band was treated and the other half left untreated indicated that the beta-naphthol and oil have no repellent effect upon the worms. Chemically treated bands, when used on apple trees of such age as to develop bark scales, have not caused commercial injury in any of the tests conducted.

BIOLOGY

A survey has been undertaken to determine the present distribution and status of the more important parasites of the codling moth in representative sections of the United States. Headquarters for this work is at the Takoma Park, Md., laboratory. To this laboratory material is sent in by bureau and State collaborators from about 25 localities, and where necessary rearings are made. The most widely distributed and useful of the parasites thus far obtained is *Ascogaster carpocapsae* Vier. It was introduced some years ago from its normal eastern habitat into the Yakima district of Washington, where it is attaining a degree of effectiveness in certain orchards. This species seems to be absent from other western and southwestern fruit districts, and the plan is to establish it in such localities as soon as practicable. At the Bentonville, Ark., laboratory investigations are under way of the predatory beetle *Tenebroides corticalis* Melsh., which in that district has been observed to be an important enemy of the codling moth.

The study of variation in the population of the codling moth throughout a representative orchard, which has been undertaken at the Wichita, Kans., laboratory, is being continued. The information obtained from this study should enable one to understand more fully the dispersion habits of the moth and should also be helpful in planning, laying out, and interpreting the results of plot experiments in the field.

At the Bentonville, Ark., laboratory, studies have been undertaken of the various factors influencing egg laying on the part of the moths. Individual pairs of moths are caged on trees in the orchard under practically normal conditions, and the variation in egg laying under different conditions of temperature, humidity, and wind movement are recorded. The information obtained will furnish a better understanding of the factors which influence the normal rise and fall of infestation, egg laying being probably more responsive to weather conditions than any other activity in the biology of the insect.

BLUEBERRY MAGGOT

Investigations relating to the blueberry maggot were continued largely along the lines already in progress at the close of the last fiscal year. The large-scale growers of blueberries in the vicinity of Cherryfield, Me., are now dusting wherever the yield of berries is sufficient to make dusting profitable. Analyses of fruits which have received necessary applications of dust have shown that the danger of objectionable residue of arsenic in the berries at picking time is small, and it now appears that an effective and practical remedy for the blueberry maggot has been developed.

The process of machine washing of berries for the removal of maggots before canning, while desirable in the absence of a better method, is objectionable because it often destroys many uninfested berries by removing the pulp, with a consequent high percentage of skins and also a loss in flavor of the berries. Furthermore, there is a loss in shrinkage, caused by the washing process, which has been conservatively estimated to be 15 per cent of the berries treated when the

maggot infestation is light and from 20 to 40 per cent of the berries when the infestation is heavy.

Life-history and biological studies of the blueberry maggot were conducted during the season of 1929 more intensively than had been possible previously. The time of appearance and duration of life of the flies, a point of primary importance in effecting their destruction by the use of calcium arsenate, has been given particular attention. During the several years that this emergence has been studied, it has been found that the interval has been short and subject to but little variation from year to year, 95 per cent of the flies coming out during the period from early to late July.

Present recommended dates for dusting in Washington County, Me., are between July 13 and 21, the application to be repeated 7 to 10 days later.

A comparative study of the maggots infesting the apple and those infesting the blueberry is being made. All stages of the blueberry form are smaller than those occurring in the apple, but no structural difference has been noted. It has been difficult to effect the transfer of eggs from the blueberry to the apple, but many successful transfers have been made.

Considerable attention has been given to the parasites of the blueberry maggot, and one species, *Opius melleus* Gahan, appears to be the most important, the percentage of parasitism varying widely. This parasite spends the winter as a full-grown larva within the puparium of the host, the adult parasite emerging in midsummer during late July and August at a time when blueberry maggots are present in large numbers in the berries. It apparently has only one generation a year in the area under consideration.

Dusting experiments in 1929 involved 176 acres divided into nine plots. About 6½ pounds per acre of undiluted calcium arsenate was used per application. The results, while not so marked as in former years, owing to the smaller number of the insects, confirmed earlier results as to the effectiveness of the dust when applied in a timely and thorough manner.

CEREAL AND FORAGE INSECTS

The work on insects affecting cereal and forage crops has been, as formerly, under the direction of W. H. Larrimer.

The most important project of this division continues to be research on the European corn borer. The other main projects are ones on which investigations have been planned covering a period of years. Among such projects are those relating to the Hessian fly, the corn earworm, the chinch bug, grasshoppers, the alfalfa weevil, and other primary pests of forage and grain crops. These investigations have been thoroughly discussed in previous reports. The newer projects of the division, or the newer phases of the older projects, are those relating to the occurrence of the alfalfa weevil in southern Oregon, the diseaselike injury of alfalfa and other forage legumes caused by leaf hoppers, the range caterpillar in northeastern New Mexico and the panhandle of Texas, and the control of the Mormon cricket in northwestern Colorado.

EUROPEAN CORN BORER

The enforcement of the quarantine against the European corn borer, as pointed out in last year's report, has been conducted since July 1, 1928, by the Plant Quarantine and Control Administration of this department. The closest possible cooperation has been maintained between the research work of the bureau and the quarantine and control activities of the Plant Quarantine and Control Administration.

The known spread of the corn borer for the season of 1929 may be considered as normal; that is, 20 to 30 miles from the known infestation. The spread in general had a southward trend for the season. The borer has been found farthest west in Boone Township, Porter County, Ind., about 30 miles from the Illinois line, and farthest south in Ohio Township, on the Ohio River, in Gallia County, Ohio. During the season of 1929 the infestation increased in those districts in northwestern Ohio which are considered particularly favorable for the development of the borer. In other districts, such as central Michigan, which are not quite so favorable for the development of the borer, there was an actual decrease of infestation. This illustrates the difficulty at this time of definitely predicting what may happen in any particular area as a result of the inevitable spread of the corn borer throughout the Corn Belt. Commercial damage to corn crops from this insect still remains small or almost negligible and is confined to the older infested area near Lake Erie and to certain particularly favorable areas in southern Massachusetts and Rhode Island. At the time of the preparation of this report—July, 1930—the moths are just concluding their annual flight and scouting for new infestation is just beginning. It will be especially interesting to determine what effect the hot and dry season, unprecedented to date, may have on spread and infestation for the present season.

The work of parasite introduction has progressed more satisfactorily during the present year than in any previous year since the work started, both as to the total number of parasites released and as to efficiency in handling available material. Up to July, 1930, there have been released during the present season approximately 600,000 parasites of 17 species. The recovery of parasites from previous liberations has been very encouraging. In some cases colonies have become sufficiently strong so that collections could be made and material shipped to the more recently infested areas, thus resulting in very appreciable saving in the cost of collection and shipment and an increase in the efficiency of distribution of parasite material, to say nothing of reduction in mortality of parasites and the elimination of all risk of introducing secondary parasites.

There has been a long-continued demand, particularly from districts where canning of sweet corn is an important industry and where sweet corn is grown for table use, for a control measure by which an individual farmer may protect his crop regardless of the cooperation he may or may not obtain from his neighbors. This has resulted in a slight expansion of the insecticide work, and by the continuation of the present program of this phase of the work the possibilities of such control will be thoroughly investigated.

Through cooperation with the Division of Agricultural Engineering of the Bureau of Public Roads there now is available special machinery for the control of the corn borer under corn belt conditions. This machinery consists of special plows, stalk cutters, rakes, and low-cutting corn binders. There is in process of development by several of the large manufacturers of agricultural machinery a corn combine intended especially for use in the control of the corn borer. With it corn is cut low, the ears are husked and elevated into the accompanying wagon or truck, and the fodder is then shredded or cut so as to destroy the corn borer and later elevated into a truck for use as silage or scattered on the ground to improve the soil. Progress in this respect has been considered promising to the extent of being almost satisfactory.

This bureau is responsible for an annual conference on the European corn borer, at which there is outlined and projected the definite participation of the various interested organizations of the Dominion and Provinces of Canada, the various bureaus of the United States Department of Agriculture, and some 25 or 30 States immediately concerned in the control of the corn borer. This project represents an outstanding case of cooperation between the bureaus of the department and the various agencies concerned in research and control of the corn borer in the United States and Canada.

ALFALFA WEEVIL

The alfalfa weevil, which originally was known to occur in a comparatively small area around Salt Lake City, Utah, has now spread by its natural ability to neighboring States where conditions affecting the control of this pest are essentially different. Control measures which consist of dusting or spraying with lead arsenate have been developed and have proved very practical for northern Utah and Nevada, but are not meeting with success in the outlying districts. During the summer of 1929 a rather severe infestation was discovered at Medford, Oreg., some 200 miles from the nearest known infestation. Incidentally this is the first known spread west of the Cascade Mountains, and in this new environment the weevil has developed habits quite different from those noted in the older infested area. In order to develop control measures a complete study of the insect has already been begun under the conditions of this new infestation.

The investigation of the manufacture and movement through commerce of alfalfa meal as a possible means of distributing the weevil has been continued. Further information has been obtained bearing out previous results indicating that when alfalfa meal is manufactured under proper precautions the danger of distributing the pest through commerce in the meal is very slight, if not negligible.

Further evidence has been obtained indicating the danger of transportation of the alfalfa weevil in freight cars used in the shipment of alfalfa hay within the infested districts.

LEAF HOPPERS AND ALFALFA

There has recently been recognized a malady known as "alfalfa yellows," "clover spot," etc., which is a new trouble for this valu-

able group of forage crops and soil builders. The injury is widespread and has been reported from Kansas eastward through Illinois and Wisconsin as far as Virginia. The investigation of the insects believed to be responsible for the transmission of alfalfa yellows and other injuries of a diseaselike nature has developed a number of secondary problems not apparent when this work was first undertaken. Preliminary studies have indicated most certainly that leaf hoppers are involved in the trouble and may be entirely responsible, and the possible occurrence of several species where one was previously considered has affected materially the plans to develop control measures for these insects. Because of a definite allotment of funds to this project these investigations can now be undertaken on a much more satisfactory basis.

RANGE CATERPILLAR

The outbreak of the range caterpillar has continued, and this insect is now doing serious damage to the valuable blue grama grass on the finest cattle ranches in northern New Mexico and the panhandle of Texas. This caterpillar, which is about 3 inches long, bears on its body many barbed spines which are extremely irritating and poisonous, both to range animals and to man. In addition to the actual grass consumed by the caterpillars there is a further loss of forage, as cattle will not eat where this caterpillar has crawled or fed, because of the webs which it spins and in which are incorporated its poisonous shed skins and spines. Owing to the very low value of the range grass per acre none of the usual methods of control are practicable. In an outbreak some 15 years ago control was brought about by the natural increase of an egg parasite of this pest. An effort is being made to speed up the increase of this parasite so that control which under natural conditions may be expected in from 6 to 8 years may be brought about in 3 or 4. Although the parasite was very scarce in the spring of 1930, it is now being bred and released in large numbers.

MORMON CRICKET

The serious outbreak of the Mormon cricket in northwestern Colorado has now been brought under practical control by the application of measures worked out by this bureau. Through cooperation with the State of Colorado control campaigns during the past two seasons have resulted in a very material reduction in the number of crickets, and there remain to be cleaned up only the outlying districts away from the cultivated areas. This final clean-up work is extremely difficult because of the nature of the country, but is necessary in order to safeguard against building up a new infestation from these outlying areas. It is hoped that one more season's work will end the present outbreak of this destructive insect.

TRUCK-CROP INSECTS

Investigations of vegetable and truck-crop insects have been continued during the fiscal year under the direction of J. E. Graf and W. H. White.

MEXICAN BEAN BEETLE

The Mexican bean beetle increased its range slightly in the Northeastern States, being found for the first time in Massachusetts and Connecticut. Injury during the latter part of the calendar year 1929 was rather heavy over the major part of the infested area. Owing to the lack of normal precipitation and the warm weather during the early part of the season of 1930, mortality of the beetle was higher than usual, and except in restricted localities injury by the pest was considerably below that of the preceding year. Apparently temperature and sunlight are more important controlling factors than is humidity, since laboratory experiments showed that extremes of dryness or saturation of the air did not have any marked effect on the development of the beetle except where these were accompanied by high temperatures. The effect of the lack of moisture under field conditions is to expose the immature stages of the beetle to the direct sunlight, as the undersides of the leaves are exposed during the heat of the day. Survival of the insect during hibernation did not differ materially from that in the preceding winter, being slightly higher in Ohio and slightly lower in the District of Columbia area and in that of Norfolk, Va.

The results of further experiments with control measures agreed closely with those obtained in preceding years. Magnesium arsenate did not injure bean foliage to any appreciable extent in any of the sections where tested, whereas the use of calcium arsenate resulted in injury in many instances. Lead arsenate caused heavy plant injury. The addition of Bordeaux mixture to calcium arsenate reduced plant injury in all cases and entirely eliminated it in several tests. The addition of Bordeaux mixture to lead arsenate, however, did not produce a safe insecticide. Plant injury by calcium arsenate varied considerably with the brands used. Pyrethrum extracts continued to give good control where used in proper dosages and particularly in cases of comparatively light infestations. Tests with cultural-control methods, including the plowing under of bean fields following harvest, showed that covering adults and larvae with 1 inch of soil resulted in killing most of the insects. Neither adult beetles nor larvae were able to reach the surface when covered with 2 or more inches of loose, fine clay or loam. More beetles reached the surface in fields harrowed or raked after being plowed than in those merely plowed.

Study of a parasite of the bean beetle in the vicinity of Mexico City was undertaken during the year. Infestations of the bean beetle in Mexico are of a spotted character and for this reason the collection of parasites proceeded rather slowly. Investigation of the biology of the parasite was undertaken in the hope that it would be possible to discover the reason for the failure of earlier parasite introductions into this country. During the year more than 2,000 parasites were sent to the laboratory at Columbus, Ohio, but attempts to carry these insects in storage over winter under various conditions met with failure.

BEAN LEAF HOPPER

Further tests on the control of the bean leaf hopper by Bordeaux mixture indicated that copper is a specific poison for this insect, that the copper from Bordeaux mixture sprayed on either beans or pota-

toes is taken up by the plant, and that the insect receives a toxic dose from the copper in the plant juices. These investigations strongly indicated that the sugars in the plant accounted for the absorption of the copper from the Bordeaux mixture. Tests in feeding leaf hoppers on copper solutions of known strength by the use of capping membranes showed that copper in weak dilutions (1:6,500) gave a rather high degree of toxicity.

SWEETPOTATO WEEVIL

Field and laboratory investigations for the control and eradication of the sweetpotato weevil in southern Mississippi and Alabama were continued. This work followed rather closely the plan pursued during previous years and included inspection of stored potatoes and seed potatoes on all farms, and supervision of planting, harvesting, and storing of the sweetpotatoes by the growers. This work was continued in close cooperation with the Mississippi State Plant Board, the Alabama State Department of Agriculture, and the individual farmers concerned. Further progress was made in reducing the number of infested farms. Since January 1, 1930, infestations have been found on only three farms in Hancock County, Miss., and nine farms in Mobile County, Ala. In addition to eradication on numerous individual farms, injury by the weevil has been almost eliminated on all farms, the insect having been reduced to such small numbers that even where it occurs it is found with difficulty.

WIREWORMS

Biological studies of the tobacco wireworm at Chadbourn, N. C., have shown that some of the individuals completed their life cycle in one year, and some in two years, while several are now in their third year in the larval stage. In these experiments the length of the larval stage has ranged from a minimum of 375 days to a maximum (still uncompleted) of 1,064 days. Injury to tobacco in the field was very light, possibly influenced to some extent by the dry spring. Attempts to determine the factors which attract the female beetles to certain fields for egg laying were a failure, owing to the small number of adult beetles collected. Practically all the insects taken on the screens treated with a tree-banding material were from 3 to 6 feet above the ground.

Experiments on the control of the sandy-land wireworm as a pest of corn gave inconclusive results. In heavily infested fields both treated and untreated plots were completely destroyed. No benefit could be detected from the use of rye as a trap crop.

At Walla Walla, Wash., further field and laboratory experiments were conducted on *Pheletes canus* Lec. and *P. californicus* Mann., the two most destructive wireworms occurring in the Northwest. The laboratory studies were concerned principally with investigation of the activity of the wireworms in the soil, the factors affecting their movement through the soil, and their food habits. A special investigation under laboratory conditions was made on the diffusion of various insecticides in the soil, together with their absorption. Field studies were concerned with the development of an accurate method of measuring wireworm populations in the field and experiments with various insecticides. A further improvement

has been made in the mechanical soil sifter. This is used not only to collect insects for laboratory experiments but also to obtain records of the densities of wireworm populations in order that the effectiveness of various control measures may be measured. While the equipment itself is efficient, it has not been possible as yet to determine the proper size of the area to be screened in order to obtain a count representative of the wireworm population of an entire field or portion of a field. Studies on the temperature requirements of the wireworms showed that the optimum for their activity was between 70° and 73° F. and that the limits of their activity was 59° and 100°. Immature stages of the wireworm desiccate readily where the soil is deficient in moisture. Wireworms showed an ability to recover after long periods of submergence in water. Young larvae a month old were able to recover after submergence for one month. A small portion of the older larvae, including those 1, 2, and 3 years of age, recovered after submergence for six days. Tests of the food habits of the wireworms gave no conclusive results, since they were able to feed and develop on the subterranean portions of a wide variety of plants. Tests of the value of rotation in wireworm control indicate that cropping with alfalfa has some effect in reducing the infestations of wireworms in certain fields and that these beneficial effects begin after the first year. Tests with pyrethrum extracts for the control of wireworms were inconclusive, and no kill in excess of 50 per cent was obtained in any case. In both Washington and Idaho surveys were made to determine the relative abundance of wireworms under various cropping systems followed by individual farmers in the hope that it will be possible to determine a sequence of cropping which will be useful in reducing the heavier losses now suffered.

At Alhambra, Calif., experiments were conducted to determine the optimum temperature for the wireworms and the depths at which they were to be found in the soil at different times of the year. Thirty-five per cent of the larvae were found at a depth of from 1 to 8 inches, a lesser number were found at 13 inches and below, while a few were taken 22 inches below the surface. In temperature experiments the wireworms were active between 50° and 97° F., while 70° appeared to be the optimum. Wireworms which were hatched in acid soils ranging from pH 1.44 to 7.28 are continuing development in these soils. Little or no effect from the differing hydrogen-ion concentration is shown, except that larvae in acid soils appear to be less active than those in alkaline soils. Work has been continued on the development of a wireworm trap in order to develop equipment for testing the attractive values of various baits in the soil without the extensive soil-sifting operations now necessary. While the smaller wireworms appear to be able to escape from these traps, it is hoped that with a slight change a large proportion of all sizes of wireworms which enter the traps will be retained. Further tests of heavy dressings of sulphur as a protection against wireworm injury have given no significant results, and the wireworm damage to potatoes grown in plots containing varying quantities of sulphur has shown no differences. Tests with various materials as stomach poisons have all resulted in failure.

SEED-CORN MAGGOT AS A POTATO INSECT

Further tests of cultural methods for controlling the seed-corn maggot, as a pest of potato seed pieces during the germination period, on the eastern coastal plain, were continued. Maggots in all stages of development were found to feed and reach maturity in seed pieces in which the cut surface did not cork over readily, as the maggots found suitable food on the decaying cut surface. Newly hatched maggots did not live when given freshly cut, sound seed pieces as their only food, but half-grown or older specimens could live upon freshly cut seed pieces. In cages where the maggots could make a choice they invariably selected the improperly corked decaying seed pieces. Maggots less than half grown, when given only corked seed pieces as food, were unable to develop. Those more than half grown were able to pupate but did not reach normal size. The adult flies became very scarce during the summer, and the peak of abundance is reached in the Carolinas during April. They are most abundant in cultivated fields, especially those that are freshly plowed. The flies have been seen feeding on flowers of almost all plants growing in or near cultivated fields. As in the preceding year, suberized seed—that which was corked over before planting—gave by far the best protection from maggot injury. As suberization of the seed appears to be a method which the growers may use readily, its early adoption generally appears certain.

SPOTTED CUCUMBER BEETLE

In view of the inability to rear the spotted cucumber beetle over summer in Louisiana, the biological work on this insect was continued through field scouting from Louisiana northward in the Mississippi Valley. Previous information had indicated that this insect is only a winter resident of the South, the beetles leaving in the early spring and returning in the fall. While no beetles could be found in Louisiana during the summer, they were found in Arkansas and as far north as Columbia, Mo. As a result of the data collected in Missouri, Iowa, and Ohio, the indications are that the species does not hibernate in large numbers as adults north of the southern portion of Missouri, and that this beetle may ultimately prove to be a year-around inhabitant of only a relatively narrow strip south of the lower part of Missouri.

BERRY INSECTS

STRAWBERRY WEEVIL

A study was made of the wild food plants of the strawberry weevil to determine their effect in concentrating the weevil in the vicinity of strawberry fields for estivation and hibernation. It was found that the new generation of weevils, after feeding on the wild plants late in the season, drop to the débris beneath the plant. Thus these native food plants indicate the location of hibernating quarters. The abundance or scarcity of native food plants in close proximity to weevil-infested fields will determine the concentration of the hibernating weevil within such areas and so serve as an index of the number of weevils that may be expected in the strawberry field the following spring. Repeated examinations of débris taken at differ-

ent distances from infested strawberry fields showed that by far the greater number of weevils were taken in the first 10 feet adjoining the strawberry planting. Sulphur with either calcium arsenate or lead arsenate applied to the plants as a dust continues to give satisfactory control in the North Carolina area. The material was particularly effective during the season of 1930, owing primarily to the scanty foliage, which permitted a more effective covering of the developing buds.

CYCLAMEN MITE

Tests were continued to develop an insecticide which could be used in treating strawberry plants for the control of the cyclamen mite. Sulphur did not kill a sufficient number of mites to indicate that it would be useful as a control measure, and in addition the strawberry plants on all plots where the sulphur was used were winterkilled during the succeeding winter. Strawberry plants were submerged for five minutes in a 2 per cent white-oil mixture at 95° F. without apparent injury, and such treated plants were apparently able to stand transplanting better than those receiving no treatment. Preliminary results indicate that the white-oil treatment gave the best control of the mite so far obtained, but this remedy must be tested further.

STRAWBERRY ROOT APHID

An investigation was undertaken to determine whether the strawberry root aphid was concerned, either directly or indirectly, with an abnormal condition of the strawberry plants which was becoming prevalent in portions of the Carolinas and Louisiana. Surveys were conducted throughout Florida, Louisiana, and the Carolinas, and no evidence was found which would directly connect the aphid with injury to the plants. The control of this insect would probably require a radical departure from present cropping methods, since it would be necessary to take into consideration the attending ants, which not only protect the aphid but carry them from plant to plant.

BEET LEAF HOPPER

Studies of the beet leaf hopper conducted in California, New Mexico, Utah, and Idaho were concerned with the effect of climatic conditions and the occurrence of various wild plants on the development and abundance of the leaf hopper. The principal objectives of this work are the accumulation of data which will make it possible to estimate probable injury from the insect and thus outline areas which as a general rule are favorable for beet culture, and the determination of factors responsible for leaf-hopper outbreaks. There is in addition the possibility that this study will disclose the feasibility of control of the insect by interrupting its host-plant sequence, either by the use of competing insects or by establishing a new plant sequence in the areas involved. As these data are carried over a larger number of years they increase in value. The investigations on host-plant susceptibility to disease are concerned with the susceptibility of cultivated and desert host plants of the leaf hopper, since this susceptibility is an important factor in determining the amount of disease carried by the insects when they invade the

beet fields. The capacity of the insects to transmit disease to the beet plants is determined by the disease-carrying ability of the wild plant from which they have migrated as well as by the survival of the disease within the insect. Data thus far obtained, from both laboratory and field studies, indicate the possibility of a definite correlation between accumulated temperatures and time of migration as well as the length of time required for the production of the brood. Breeding areas in the same section may react somewhat differently to winter conditions, and fall conditions of rainfall apparently play an important part in determining the spring populations of the insect. A more intensive survey of the desert areas indicates the importance as migration centers of certain localities not previously suspected. The fourth prediction of probable leaf-hopper abundance in the Twin Falls district, which was based both on hibernation data and on the type of winter, was issued at the end of February. The winter, although showing some divergence therefrom, was closest to that of 1921-22, which preceded a season when an average beet tonnage of 13.52 was produced per acre. Although at the time of writing tonnages for this season are not yet available, it is certain that damage will be greater than indicated by the February prediction. Heavy leaf-hopper flights occurred during the period from May 24 to June 17, coming from a northwestern direction and from areas not previously linked with serious infestations of the Twin Falls district. Traps placed around the areas growing sugar beets have given accurate information regarding direction and time of flights, and this is correlated with the infestation in the fields and the development of disease. Data relative to the height of the flying season have also been obtained by this method, and there appears to be a correlation between the heaviest flights and high temperatures.

Studies on the value of chemical attractants and repellents for the leaf hopper have given only negative results. To judge from tests with insecticides, the beet leaf hopper apparently is not susceptible to copper, as is the potato leaf hopper. Experiments with oil sprays, particularly those of the light oil-Pyrethrum type, indicate thus far that owing to the inadequate kills this method will not be available as an economic measure. The studies of parasites have shown that during the past year several species occurred 200 miles to the north of the range of the beet leaf hopper, and thus their non-specificity is indicated. Five species of egg parasites have been reared from leaf-hopper eggs in dry Russian thistle, and this appears to be the principal manner and place of overwintering of the parasites in southern Idaho. Laboratory studies include investigation of the life cycle of the parasites, their egg-laying capacity, host range, etc. Such data are necessary not only in determining the parasite requirements for leaf-hopper control but also in furnishing an explanation for the inefficiency of the parasites present.

TOBACCO INSECTS

TOBACCO HORNWORM

The growing objection to the arsenical residue left upon tobacco has indicated the importance of expediting work on the control of tobacco insects by methods which do not necessitate application of

an arsenical. Amyl salicylate has been known for several years to be attractive to the horn-worm moths: but since large screen cages were necessary for trapping the moths drawn to the bait, this method could not be used satisfactorily in field practice. In 1929 an apparatus was developed through which the moths were fed a poison. This poison feeder had to be visited only twice a week, whereas it was necessary to attend the traps every day for satisfactory results. Three white funnels, to simulate the Jimson-weed blooms, the favored feeding flower of the tobacco hawk moth, led into the feeder, in which was contained a sweetened and poisoned liquid. Upon the feeder was placed a vial containing amyl salicylate, which served to attract the moths near enough so that they would react to the painted funnels. Thirty-nine of these feeders were exposed in an area containing 9 square miles at approximately half-mile intervals and in the proportion of one for each 9 acres of tobacco. While the efficiency of this treatment could not be determined with accuracy owing to the size of the treated area, control obtained by this method averaged a little above 50 per cent as determined by comparison with check fields outside the baited area. This was the first field trial of the poisoned-bait method and indicates that better control may be expected with an improved feeder used in greater numbers. While the exact degree of usefulness of the method remains to be proved, it is popular with farmers and would readily be adopted if its usefulness were demonstrated.

TOBACCO STALK BORER

Further studies on the tobacco stalk borer in Arizona have shown an abundance of wild host plants of several genera on which the insect is capable of living. Tobacco, potato, and eggplant are the only cultivated plants naturally attacked by the borer. The different types of cultivated tobacco vary in their resistance to borer attacks. *Nicotiana rustica*, a tobacco of high nicotine content, is much more susceptible than many others, plantings being killed outright by the borer, and thus far it has been impossible to protect the plants from serious commercial injury. There is, however, a promise that control methods can be developed which will be useful on other varieties of tobacco. Arsenical sprays and dusts show a repelling effect on the adult borers both as to feeding and as to egg deposition. As many as three overlapping generations of the stalk borer occur annually and this makes it necessary, to protect plants in seed beds, to dust them heavily with arsenicals as soon as they are set out in the field, and to continue the dusting at regular intervals throughout the season.

ARSENICAL RESIDUE ON TOBACCO

A cooperative study with the Bureau of Chemistry and Soils on the quantity of arsenic remaining on the tobacco plant at harvest, after regular treatments with Paris green and lead arsenate for the control of hornworms, has progressed to the point where some definite results may be expected by the end of the season.

MUSHROOM INSECTS

The investigation of mushroom insects and other pests which attack this crop has continued primarily along the same lines as last

year, with special emphasis upon the value of sanitary measures in checking losses. Preliminary experiments have shown definitely that the proper composting of the manure has an important bearing upon infestation of mushroom houses with mites and flies, in that the compost must reach a high enough temperature when it is going through the heating process in the house either to kill any animal life in it or to drive the pest out of the compost where it can be reached with a sulphur or hydrocyanic-acid-gas fumigation. Artificial circulation of the air within mushroom houses in order that the beds in the lower part of the house may reach practically the same temperature as that in the upper part of the house has been practiced with good results. This artificial circulation has been brought about by the use of the ordinary oscillating house fan. Another factor in equalizing the temperature in the beds during the time that the compost is going through the heating process in the house is the raising of the lower bed of the house to 6 inches or more above the ground. If this is not done the temperature will not rise in this bed to a sufficient height to kill or drive out the pests which may be in the compost, and these lower beds will serve as a source of reinfestation to the rest of the house. The indications are that steam sterilization of the surface of the compost pile can be used to good advantage in checking mite infestations. Screening of doors and ventilators with 30-mesh wire has proved of practical value in reducing the losses from mushroom flies. Another factor in preventing losses from mushroom pests is keeping the temperature of the house below 55° F. during the cropping period. Temperatures higher than this serve to promote the rapid multiplication of both mushroom flies and mites.

Ethylene oxide, combined with carbon dioxide to reduce accidents, shows promise, from preliminary experiments, of being useful as a fumigant in mushroom houses, as this fumigant will penetrate uncased compost and kill mites and the larvae of the mushroom flies contained therein.

A development which has proved to be of considerable value to the growers in the control of mushroom flies consists in the improvement of the physical qualities of pyrethrum powder. This has been accomplished by mixing 60 per cent of the pyrethrum powder with 40 per cent of diatomaceous earth. This diluted powder stays in suspension in the air longer than when undiluted and is consequently more effective.

The mite *Linopodes antennaepes* Banks was discovered for the first time doing commercial damage in two localities, the greatest loss from this pest occurring in Ohio.

PEPPER WEEVIL

Experiments in 1928-29 indicated that while the pepper weevil could be effectively controlled by the use of calcium arsenate, under certain conditions aphids would increase to injurious numbers and cause considerable loss to pepper plantings. In view of this possibility many growers were reluctant to use calcium arsenate, and it became necessary to depend to a larger extent upon the cultural methods which had given promise. Field experiments showed that adult pepper weevils survived the winter only in cages containing nightshade or pepper plants and that where host plants do not

survive in the winter weevil infestations the following year are of little importance. Minimum winter temperatures below 30° F. reduce host-plant survival and consequently weevil population. If the winter temperatures do not drop below this point heavy infestations may be expected especially where there are sufficient wild host plants to carry the weevil over winter. During the winter of 1929-30 a large percentage of the nightshade was cleaned up, and the growers are becoming convinced that destruction of nightshade and pepper plants after harvest is one of the necessary steps in pepper culture. Experimental tests with calcium arsenate applied as a dust during August and September, 1929, gave a considerable increase in the yield of peppers, and in no case did aphid infestation follow treatment. The growers, however, preferred to take a chance on the weevil rather than on the possibility of aphid damage, particularly in view of the fact that the arsenical residue must be removed before the peppers are prepared for market.

PEA APHID

In connection with the pea aphid, studies are being continued to determine the relationship between plant growth and aphid injury in order to find an index which will show when treatment for the aphids is necessary. Determinations of plant samples include length, green weight, dry weight, moisture content, and sap concentration. At the same time measurements are being made of the extent and intensity of infestation, of factors influencing the peak of infestation, and of the effect of heavy infestations on the pea vines. Experiments to determine the factors influencing the hatching of overwintering eggs indicate that the percentage of hatching was highest in eggs entirely exposed or with only a little covering and that heavier coverings of various materials appeared to be unfavorable.

CELERY LEAF TIER

Further studies on the biology of the celery leaf tier failed to show where or in what stage this insect spends the summer. Experiments devised to test the ability of the pupae to withstand moisture show that this stage of the insect can not emerge after being in contact with excessive moisture for more than 48 hours. Since the rainfall in Florida averages over 6 inches per month during the summer, it appears doubtful if the insect lives over the summer as a pupa. As usual the moths appeared in the fall after a marked drop in temperature. This occurred on September 23 following the first heavy rain. Female moths captured at this time laid an average of 37 eggs during the first night and lived only a short time. A careful study was made of birds and other natural enemies of the celery leaf tier. Over 226 bird stomachs were collected and examined and several species showed a preponderance of the celery leaf tier in the diet. The stomach analyses gave conclusive proof of the fact that the common birds, both migratory and native, destroy large numbers of the celery tier, and it is possible that during a season that is normal so far as temperature is concerned they play a large part in preventing outbreaks of the pest. Control experiments with various chemicals did not yield any material more effective than pyrethrum dust.

EUROPEAN EARWIG

In connection with the European earwig, special attention has been given to a determination of the food preferences of the insect through an extensive examination of stomachs from various sources. Study of the food of earwigs shows that the main food is of vegetable origin and that under certain conditions these insects are capable of damaging almost any kind of vegetation. Early in the season spores of fungi and pollen are important elements in the food, dandelions and grass also being included. In addition to vegetable foods, the earwig regularly includes animal matter in its diet. This consists largely of aphids and other small insects. But in spite of this habit, aphids have been found damaging roses and other plants on premises heavily infested with earwigs. Reports on this insect from Europe show that as a rule it is regarded as injuring plants, though a small number of investigators claim that owing to its insect-feeding habits it is somewhat beneficial. Data have been accumulated on the seasonal history of the earwig and on the potentialities of the insect as an agricultural pest in rural districts. A survey was made in Portland, Oreg., of the area in which an earwig parasite imported from Europe had been previously liberated. No trace of the parasite could be found, and it appears improbable that it has been established out of doors in Portland. Control experiments have been concerned principally with the testing of various baits and poisons. The poisons showing special promise were thoroughly tested at several dosages. Two types of bait traps have been developed and tested, and one of them gives promise not only of aiding in the concentration of the earwigs but also of maintaining the bait in satisfactory condition over long periods. A bait of wheat bran, fish oil, and sodium silicofluoride gave the best results, both in the presence and in the absence of green food. The exact degree of effectiveness of any poison bait, however, is difficult to determine, since the insects wander about so freely at night that the checking of results obtained can not be done with any degree of accuracy except where the baiting experiments are carried out over wide areas. Studies are being made at several points in the Northwest in order to determine the relation of climatic factors, such as humidity and rainfall, to the distribution and occurrence of the earwig.

VEGETABLE WEEVIL

In California there was one generation of the vegetable weevil in 1929. The first eggs of the year were laid by oversummering adults late in September, and the first grubs were found in the field in early October. Egg laying continued until January. The adults become inactive in the early summer and remain so until fall. The weevil caused considerable injury to carrots and turnips, but the growers were slow about using control measures, many of them waiting until the major portion of the injury had been done. Work on baits was continued, but the promising preliminary results obtained with certain baits in the previous year could not be duplicated. More weevils were collected under old sacks and boards placed between the rows than in the traps. It seems clearly demonstrated that the fall infestations come into the fields from weedy fence rows, and

an attempt will be made to test clean culture on a large scale. In the Gulf region the vegetable weevil is now known to occur in 117 counties in Mississippi, Louisiana, Alabama, and Florida. The spread to the north has been considerably slower than in preceding years. The weevil appeared to survive the cold weather of last winter successfully. Surveys along the northern line of infestation where air temperatures had dropped to as low as 7° to 10° F. resulted in the finding of all stages; the weevils, however, were protected by several inches of snow.

INSECTICIDES

Physiological investigations have been continued in order to determine the effect of the various poisons on insects, with the hope that such studies will lead to the successful development of a stomach poison for wireworms. The investigations included: (1) A study of the enzymes present in the larval and adult potato beetle and of the effect of arsenicals upon their activity; (2) development of a method for determining microscopically the relative distribution of arsenic in insect tissue; (3) determination of the toxicity of contact insecticides as measured by their effect upon the respiratory metabolism of insects; and (4) toxicity studies of wireworms. The work last mentioned has shown that certain poisons give promise of killing these larvae, but since these are repellent to the insects it is necessary to find a chemical which possesses attractive or neutral qualities and at the same time will kill them.

COTTON INSECTS

Investigations of insects affecting the cotton plant have been continued under the direction of B. R. Coad.

The principal change in cotton-insect investigations during the year has been an expansion in the studies of insect pests other than the boll weevil, thus continuing the trend which started several years ago. Nevertheless, the boll weevil still continues to receive the greatest amount of attention.

BOLL WEEVIL

A 15-year period of study of the hibernation, winter survival, spring emergence, and resultant damage of the boll weevil in the Mississippi Valley has been completed, and the first of a series of manuscripts dealing with the various phases of this subject has been prepared. In addition, analyses of similar studies at points elsewhere in the Cotton Belt have been made for comparison with Mississippi Valley conditions, and this general study of records has made possible some revisions in the plan of operation for both the intensive work at Tallulah, La., and the extensive observations elsewhere. At Tallulah it was found that the average winter survival of the weevil over a long period of years was approximately 1 per cent and that, contrary to previous expectations, the winter mortality is more directly influenced by the number of times the temperature goes below freezing than by the extreme minimum temperature of the year.

Comparisons of different hibernation shelters indicate their relative importance in various seasons. These can be very closely correlated with the distribution of infestations in the fields in the spring, and thus a more intelligent control program can be planned. Some materials of great importance as hibernation shelter in mild winters do not afford sufficient protection to be of the same relative importance in colder winters.

Studies on the direct control of the boll weevil have centered largely around improvement of dusting machinery and technic and comparison of different methods in different districts. The high-air-velocity dusters have been placed in extensive commercial use as far as the larger types of machines are concerned, and the same principle has now been incorporated in other types as small as the 1-mule duster. Experimental models involving the use of this principle have also been developed for riding, walking, and power cultivators. Some tentative types, particularly for use on power equipment, have reached the first steps of commercial production, but they must be developed still further before they can be placed in general use. The most important effect of this development is the increasing extent to which daytime dusting can be carried on. Machines are now available which permit successful control of the boll weevil with daytime operation in many districts where conditions are particularly favorable, and the present investigations are so improving the equipment and methods that it will soon be possible for other districts to dust their cotton in the daytime.

An increasing necessity for the use of insecticides in combination for the simultaneous treatment of two or more pests has considerably complicated the dusting-machine problem, and during the year much attention has been devoted to the calibration and modification of the older types of machines so that they can be used for the various combinations of calcium arsenate, nicotine, sulphur, Paris green, and other materials now being recommended for various applications. This has brought up new problems, such as that involved in the cohesion of mechanical mixtures of this sort, and has necessitated the study of the swath distribution of these insecticides applied in various mixtures from the different types of machines. For example, a material like Paris green has a tendency to separate from lighter, fluffier materials with which it is mechanically mixed, and when the two are blown into the air together the swath made by the Paris green is not so wide as that made by the lighter material. In some cases this condition has been remedied by the use of materials which increase the cohesion. Along with these studies other insecticides have been tested as usual, as well as various ideas of weevil control which are constantly being suggested. Special attention in both the laboratory and field-plot work has been devoted to such materials as the different fluosilicates and special grades of calcium arsenate supplied by the United States Chemical Warfare Service and others. So far, tests with none of these materials have progressed far enough to justify recommending their commercial use for weevil control, although in some instances results have been sufficiently favorable to warrant recommendations for use against other insects. For instance, the use of fluosilicates against the cotton leaf worm was developed as an incident in the studies and was particularly

advantageous during the season of 1929 at some points where there happened to be a shortage of arsenicals.

Plot tests of weevil control have been conducted every year at Tallulah for the past 14 years. The tests conducted last season showed that weevil damage for the year in that district was comparatively light, the average gain in pounds of seed cotton per acre in this series of tests being only 174 as compared with a maximum for the other years of 696. These figures are far below the average for the period of observation.

The cooperative investigations in South Carolina were again expanded slightly to include more studies of weevil flight and field activity and of some additional conditions in the poisoning tests. During the calendar year 1929 better results were secured from the early-season tests in South Carolina than in any preceding year and, because of the comparatively heavy damage prevailing, there was a very high average increase in the yield where the standard method of dusting was followed, the average gain for all tests being 666 pounds of seed cotton per acre. The regular weekly surveys throughout that State have been maintained, and the information obtained from them has been transmitted to the Extension Service for use in timely advice to the farmers.

The Oklahoma cooperative investigations showed quite a different picture from that of the preceding year. The initial spring infestation of weevils through the eastern half of the State was fairly heavy, following emergence from hibernation, and there was every indication that extensive efforts of control would be necessary. However, because of an extended period of exceedingly hot, dry weather, in only a few isolated localities did enough infestation develop to cause commercial damage. Research-plot tests were planned, as during the preceding year, at Hugo, Ada, and Muskogee. At the first two places natural control took care of the situation, and no poisoning was necessary. In Muskogee, however, in some of the bottom lands there was a greater degree of weevil activity and the plot tests in this district showed an increased yield from poisoning amounting to 444 pounds of seed cotton per acre. These studies combined with the regular weekly surveys made it possible to keep the State extension authorities thoroughly posted as to the progress or lack of progress of infestation in the different districts, and they in turn carried out a very intensive campaign, advising the farmers where it was necessary to poison and where it was not necessary to do so, thus enabling many farmers to save unnecessary expense. In connection with the extension workers' program some several hundred demonstrations of poisoning in various localities were carried out in such a way that considerable research information resulted. This will be of assistance when final recommendations for weevil control under the various conditions existing in that State are being worked out.

The unusually cold winter of 1929-30 in Oklahoma afforded the opportunity for some special observations on winter survival. Throughout much of the territory where boll weevils are normally most injurious in that State minimum winter temperatures ranging from -10° to -15° F. were experienced. Some 20 years ago, shortly after the weevil first reached that territory, similar winter conditions

prevailed, and consequently the weevil in the State was almost annihilated. In order to check up on the present effect of such a winter special attention was devoted this spring to the degree of infestation in the fields following emergence from hibernation. It was found that, in spite of the cold winter, a very fair average spring infestation resulted. Thus evidence additional to that obtained elsewhere that the weevil is tending to adapt itself to the more extreme climatic conditions has been secured.

Flight studies on the weevil have proved of such value in connection with control operations late in the season that these are now being standardized and included in the regular studies. The field observations on chemotropism have been combined with the flight-screen records and the attractants developed from the extracts of the cotton plant are exposed on some of these flight screens. To date these attractants, which seemed very promising under laboratory conditions, have not given such positive results in the field, but a considerable series of various mixtures, dilutions, etc., remains to be tested.

The plantation-control studies, dealing largely with the possibility of decreasing weevil infestation on property through fall and winter control measures, as well as general removal of hibernation shelter, are now showing rather definitely that the decreased amount of poisoning required quickly offsets the expense of these control measures.

COTTON FLEA HOPPER

Laboratory studies of flea-hopper damage have permitted some rather definite conclusions, and a preliminary report has been submitted for publication. More than a dozen species of hemipterous insects have now been definitely proven to cause this damage. Laboratory studies have failed to indicate the presence of any virus or organism transmitted by the insects, and the evidence to date indicates that the disturbance is brought about by some form of toxin, probably of a salivary nature, injected with the puncture. The fact that this damage is caused by numerous species made necessary the inclusion of all of these in complete life-history and biological studies as well as observations on their abundance and activity in various portions of the Cotton Belt. Observations are now under way throughout the season at various points extending from South Carolina to the arid West, giving the complete seasonal activity of all of these potential pests, in the cotton crop as well as on other host plants. Generally speaking, the true flea hopper, *Psallus seriatus* Reut., is the most important species concerned, particularly in the more western areas, but in the Mississippi Valley the tarnished plant bug frequently predominates, and in the Southeastern States some of the leaf hoppers apparently are most important. From a commercial viewpoint, damage from this cause was only of local importance during the season of 1929 except in the western portion of the Cotton Belt, and particularly in central Texas. Here the flea hopper was the most injurious pest of all, over a very large area.

Control studies have now been expanded to include numerous new forms of sulphur as well as other materials, particularly nicotine, which has yielded some rather promising preliminary results.

THURBERIA WEEVIL

The *Thurberia* weevil continues to increase in the areas of cultivated cotton where infestation had been reported previously, but fortunately no new areas of infestation were detected during the calendar year 1929. The studies of life history and biology have now started into the sixth year of continuous breeding on cotton, and a steady adaptation to the conditions of cultivated cotton is being noted. As a consequence, each year the same infestation in the spring results in a heavier ultimate damage to the crop. Because of the extent to which it still adheres to some of the habits acquired in connection with its natural host plant, however, its infestation can still be held below that which would result in serious injury, by such simple control measures as seed sterilization and winter clean-up.

PINK BOLLWORM

The pink bollworm research carried out in cooperation with the State of Texas has continued to expand rapidly. Among the more important results are those in connection with flight and movement, and one of the most interesting developments of the present season has been the establishment of the fact that the moths have a definite spring-flight period following emergence from hibernation as well as a similar late-season flight. The extent and duration of these flight periods are being determined by such means as flight-screen records and trap plantings. All evidence indicates the importance of the Laguna district of Mexico as a source of moths which may fly into the United States.

Studies of cultural control have yielded positive results. They indicate that a comparatively high mortality can be brought about by winter-control measures at very little expense. For instance, where plowing as deep as 4 inches can be followed within not more than two weeks by an irrigation of at least 6 inches, a mortality of from 97 to 100 per cent can be effected. Plowing without the irrigation is not nearly so effective but there are indications that it has some merit, and special studies on this subject are being conducted for the benefit of those areas where irrigation is not possible. The laboratory at Tlahualilo, Durango, Mexico, is being continued in operation and is devoting particular attention to the question of whether or not infestation can be maintained on host plants other than cotton. Several different host plants, notably okra and a species of wild Hibiscus, have very frequently been found to contain infestations, but so far this has occurred only in the presence of infestation in near-by cotton. In connection with any problem of possible eradication it is most important to know whether this species can maintain itself on these hosts in the absence of cotton. So far the evidence on this subject is negative, but it is by no means conclusive.

Methods and costs of destroying the pink bollworm in gin trash by burning and by steam heating have been worked out, but the most interesting results have been in connection with the grinding of this trash in some form of mill which will kill all insect stages present and still permit the later use of the trash. Sufficient progress has now been made to permit development of a mill that will handle a maximum of about 1,500 pounds of trash per hour with a requirement of approximately 5 horsepower and still grind the material

fine enough to kill all insect stages present. Such an experimental mill was set up in the Laguna district of Mexico, and even the coarsest grinding tested gave 100 per cent control of the insect stages. An interesting feature of this development has been the fact that this ground trash has a decided potential value. Even without special treatment it can be used either as a feed or as a fertilizer, and one large company which installed an experimental mill had no difficulty in disposing of some 15 carloads of ground trash at a price which made the operation financially attractive. Furthermore, there is very definite promise that, by developing a suitable separating system, lint of considerable value can be reclaimed and the residue of ground trash thereby greatly increased in value as feed stuff.

During the year the first importations of *Microbracon kirkpatricki* Wilkinson, a parasite of the pink bollworm which has brought about as high as 75 per cent control in the Kenya Colony of British East Africa, were made. Arrangements were made for the cooperation of the British entomologists, and two shipments were received in January and February, the second of which arrived in very good condition. Every effort is being made to perpetuate these insects and to arrange for further introductions until sufficient material can be bred for field release to determine the possible value of this parasite in the United States.

BOLLWORM

Still further emphasis has been placed on the bollworm investigations, and these have now been combined with the general cooperative study which is being carried out with the Texas Agricultural Experiment Station, with headquarters at College Station, Tex. In this study the bollworm receives the major attention, but along with it an effort is being made to develop suitable measures for dealing with the peculiar cotton-insect problems of that district, where two or more major pests are always present. Investigations during the season of 1929 disproved some disturbing ideas which had arisen during preceding years. For example, there has been some feeling that under certain conditions the use of arsenical poisons such as calcium arsenate increased rather than decreased the bollworm infestation, and therefore many farmers were afraid to poison for the boll weevil for fear of increasing the bollworm damage. This idea has been definitely disproven. Furthermore, an investigation to determine whether bollworm moths are attracted by the honeydew to fields heavily infested with aphids has also yielded negative results. At the same time, in tests carried out during the season of 1929 it was shown that the use of an arsenical poison did control the bollworm. Both laboratory and field-plot studies were conducted with various insecticides, such as arsenicals and fluosilicates. The best results on the average were obtained with calcium arsenate, although there is some indication that the addition of a slight quantity of Paris green to the calcium arsenate may be worth while. Special studies were conducted with Paris-green mixtures, both those mechanically mixed and those mixed wet during manufacture. So far the results indicate that the mechanical mixtures made at home are as good as the factory mixtures, but this point needs further verification. Tests to date have centered largely around a mixture containing 25 per cent of Paris green, but this is a rather high percentage for

commercial use, and current investigations are dealing with lower percentages. An interesting side light on the investigations of the season of 1929 in the Brazos bottoms near Bryan, Tex., was the fact that, while the first brood of bollworms on the cotton could be controlled by poisoning, the flea-hopper damage at that time was so great that there was little, if any, advantage from the destruction of bollworms, and it was not until the coming of the second brood that bollworm control actually brought about an increase in crop yield. In spite of this failure of the plants to take advantage of protection at the time of the first brood the bollworm damage was so heavy during the period of the second brood that the calcium-arsenate control plots still showed an average increase in yield from dusting of 418 pounds of seed cotton per acre. This was, of course, a season and a locality of unusually heavy bollworm damage.

INSECT MIGRATION

The question of migration and movement, whether only interfield or of an extended nature, is of prime importance in connection with so many cotton pests that this study has now developed into a broad one of the fundamentals involved in such activity. This is accomplished frequently in connection with the other investigations under way on the various pests and is brought about by such observations as infestation surveys, flight-screen observations, airplane collections, and field sweepings. The flight screens are being used in conjunction with so many pests and are yielding such important data that it is becoming obviously necessary to standardize the technic utilized. A very elaborate series of tests has therefore been inaugurated, involving screens at all altitudes from 3 to 50 feet from the ground, screens ranging from 1 to 10 feet square, and screens of different shapes, as well as coated with various grades of adhesive material. So far there has been some indication that the shape of the screen and the presence or absence of possible air eddies may have a definite influence on the results secured, particularly in connection with the flight studies of the pink bollworm. The flea-hopper studies, particularly in Texas, indicate increasingly that the problem in many sections is dominated by the question of flight or air movement. The same applies to other pests, notably the bollworm and the leaf worm.

COTTON LEAF WORM

Studies of the cotton leaf worm have dealt largely with the factors influencing the direction and distance of its movement as well as with the possibility of preventing or at least retarding its spread through the United States by control measures in southern Texas where it first appears each year. During the growing season of 1929 commercial control activities in southern Texas retarded spread over the other cotton areas by not less than two months, and this permitted growing a successful crop in many districts before the leaf worm arrived. Another interesting feature of that season was the fact that while the moths of the September generation, which normally become most widespread of all, were most active, the prevailing winds were from the north; as a result, there was much less migration northward than normally.

COTTON APHID

The cotton louse has continued to receive considerable attention, especially in connection with the development of infestations following poisoning. Recommendations for dealing with this situation have been rather definitely worked out, and a popular publication has been issued on the subject as well as more technical publications dealing with the factors concerned. It is now found that by the addition of sufficient nicotine sulphate to give a 2½ per cent nicotine content to the calcium arsenate used for weevil control complete commercial control of the louse can be brought about in almost every instance by a single application.

COTTON LEAF PERFORATOR

The cotton leaf perforator, which has attracted particular attention in the Imperial Valley of California, was especially injurious during the season of 1929, and it has been necessary to reopen this investigation on a more elaborate scale than before. Some of the control studies have indicated the possibility of bringing about a comparatively high degree of larval mortality with the use of arsenical insecticides, and one especially interesting development was the fact that an adult mortality of over 70 per cent was noted to follow the use of nicotine dust. These studies now include all phases of life history, biology, and activity, as well as control tests.

MISCELLANEOUS INSECTS

In addition to the foregoing major problems it has been necessary to devote the usual amount of attention to the outbreaks of other cotton insect pests that have occurred from time to time. These have involved such pests as grasshoppers, crickets, cabbage loopers, salt-marsh caterpillars, and numerous others. Whenever these outbreaks occur and can possibly be reached special studies are conducted on the nature of the infestation, and such control measures are tested as seem justified under the circumstances.

TROPICAL, SUBTROPICAL, AND ORNAMENTAL PLANT INSECTS

The work under this heading has, as formerly, been under the direction of A. C. Baker.

MEDITERRANEAN FRUIT FLY

The subject of particular interest in this field has had relation, as last year, to the occurrence of the Mediterranean fruit fly in Florida. The experimental work which falls under the field of this bureau in relation to this newly introduced pest was discussed with some fullness in the report for 1929; namely, (1) the development of effective sprays and (2) of attractants for the adult fly; (3) a survey of the wild fruiting plants in the infested territory; (4) determination under cage conditions of the susceptibility of such wild fruits to fly attack, as well as of any cultivated fruits grown in Florida the fruit-fly status of which was unknown; and (5) the determination of methods of treatment of fruit or vegetables which can be

relied upon as eliminating the risk of distribution of this pest to other parts of the country by movement in commerce of such articles.

As a result of the intensive spraying and other control measures which were used in the invaded area the fly practically disappeared from Florida in August of 1929, the last finding of adult flies in that year having been on August 27 and the last finding of larvae (four in one orange) on November 16. Since that time two very light infestations have been discovered. On March 4, 1930, several larvae were found in two fruits on one sour-orange tree near Orlando, and on July 25, 1930, two pupae were found in soil under a sour-orange fruit in a dooryard in St. Augustine.

In view of the practical absence of the fly, it was deemed desirable to discontinue work with living material in Florida, and the 1st of March, 1930, arrangements were made to conduct any further tests involving such material in Hawaii. The rounding up of other work in Florida concerned particularly the completion of the tests relative to the different types of sprays and of attractants and bringing to a conclusion the wild-fruit survey and the testing of such fruits as to susceptibility to fly attack.

In the course of the wild-fruit survey it was found that 43 fruits occurring more or less widely in the State could serve to propagate the insect and continue infestation. Eight of these were state-wide in their distribution, 6 were distributed throughout the peninsula of Florida, 11 were confined to the upper half of the State, 2 were distributed in the central peninsular region, 3 occupied the entire coastal area, 10 were confined to the lower half of the coastal area, and 3 were rare and reported only locally. These findings indicated the difficulty which would attend any eradication effort should there have been a general infestation of such wild hosts. Very fortunately the surveys indicated no such wild-host infestation. On the other hand, in the wild land, such as hammock areas, where citrus groves had been planted, there were many instances of the fruit fly having reached such groves, many of which were growing under hammock and other conditions similar to that of the wild hosts. The explanation apparently is that the human contact was frequent and regular with such plantings, involving the transfer in some instances of picking crates, citrus fruit, and other means for carriage of larvae and pupae of the fly. There would seem, therefore, to be little basis in the mere location in hammock or similar wild-land areas to give immunity to wild fruit from infestation.

The further study of poison-bait applications for adult flies has confirmed the practicability and usefulness of copper carbonate¹ as a substitute for arsenical poisons, and this new spray was utilized widely during the season of 1930 by growers and others in interest throughout the old infested portion of the State.

The work with traps to measure the effectiveness of spraying, and more particularly as an aid to inspection by indicating the presence or absence of the fly, has been continued in the hope of finding a more efficient attractant. Ordinary coal oil or kerosene has continued, however, to be the most satisfactory attractant, and while only males

¹ Copper carbonate bait spray for the Mediterranean fruit fly: The bait spray developed in 1929 and now recommended for general use has the following formula: Copper carbonate, 8 pounds; sirup (blackstrap), 5 gallons; sugar (soft brown), 25 pounds; water to make 200 gallons. This spray is recommended for use at the rate of 1 pint for eight trees or about 1 gallon per acre.

were attracted to traps thus baited the fact of the occurrence of the sexes in about equal proportions makes the collection of males a satisfactory measure of the abundance or even presence of the insect.

The experimental work to determine the relative susceptibility of different host fruits and vegetables was continued and covered the more important Florida products. This work indicated that there was practically no risk, under conditions of culture employed in Florida, attaching to string beans and cowpeas and that the risk as to certain other vegetables known to be occasionally infested was very remote. Accordingly, these various vegetables—i. e., string beans, cowpeas, and also pumpkins, gourds, squashes, and cantaloupes—were released from all restrictions for production and shipment. In the revised quarantine, effective September 1, 1929, certain restrictions and safeguards still applied to peppers, tomatoes, eggplants, and broad and Lima beans.

The research work involving living insects, elsewhere referred to as transferred to Hawaii, has dealt largely with the question of securing more information on the sterilization of fruit and vegetables by either heat or cold—methods which were described in the report for 1929.

The method by refrigeration, while entirely successful and practicable, and actually utilized very largely as to the crop of 1928–29 in commercial movement of fruit, nevertheless called for accuracy of handling to prevent the overcooling and possible freezing of fruit. It will be remembered that the refrigeration required in connection with the crop of 1929 called for subjection of the fruit to a temperature of 28° F. for five hours and thereafter the holding of such fruit for four and one-half days at 30°. This treatment gave complete mortality to the fruit-fly larvae and, when properly conducted, no injury to the fruit. In view, however, of the risk of freezing the fruit, it seemed highly desirable to determine what could be done with temperatures at or above freezing point. Some rather extensive experimental work in this direction was conducted in Hawaii during the winter and spring of 1929–30, and without exception it was found that a temperature of 30 to 31° for 15 days was fatal to any eggs or larvae that might be present in the fruit. These temperatures are well within the range of standard cold-storage practice and can be easily maintained without risk of freezing, and this new method was adopted toward the end of the last shipping season in the spring of the current year and will hereafter be available for general commercial practice.

MISCELLANEOUS SUBJECTS

The work of the Division of Tropical, Subtropical, and Ornamental Plant Insects covers a number of other very important projects. Some of the outstanding developments of the season as to these projects are briefly indicated below.

The research work on the Mexican fruit worm has been continued in the laboratory in Mexico City. These studies have been concerned more particularly with the biology of the insect and its reaction to temperature and other conditions of environment. The temperature response is the subject of a paper which has been prepared for publication. A special study of parasitism through a full year period has been completed, and in connection with other work a high

mortality of adults has been secured from the use of copper compounds in line with similar results obtained with the Mediterranean fruit fly in Florida.

The very important international project concerned with the importation of parasites of the citrus black fly into Cuba, carried out in cooperation with the Cuban Department of Agriculture, is reaching what promises to be a very successful conclusion. The first shipment of parasites, *Eretmocerus serius* Silv., arrived April 21, 1930. Several generations of these parasites have now been reared in Cuba, and recoveries are being made from colonies established in the field. Mr. Clausen, who has been in charge of the parasite studies and collections in the general Singapore district, is now en route to America with a considerable shipment of parasites and predacious insects of various types. Preparation for the handling and distribution of these parasites has already been made. It is hoped that the insects in these shipments, together with the parasite above referred to, will prove to be very efficient natural controls for the black fly in Cuba and be available for colonization in Florida should the black fly become established there.

Work on bulb pests has been continued at the laboratory at Sumner, Wash., at the new laboratory in Whittier, Calif., and at the new laboratory at Babylon, Long Island, N. Y. At these laboratories work has been conducted on the perfecting of fumigation methods. Also, in relation to this work, the new heat or vapor method of sterilizing citrus fruit, developed at the Florida laboratory in connection with the research on the Mediterranean fruit fly, has been applied experimentally and successfully to bulbs and also to ornamental plants in full leaf. The results are promising as offering a means of sterilizing bulbs, and plants in foliage, without injury. Moreover, the vapor method is cheap, permits handling in large quantities and in various types of containers, and the subsequent drying of the product. For experimentation on a commercial scale, sterilization plants of this type have been installed in the laboratories at Sumner and Babylon.

At the New Orleans laboratory, as in the past, the major effort has been devoted to the study of oil emulsions as sprays for the control of scale insects. Several phases of this work have been completed, and manuscripts are being prepared for publication. These cover three rather distinct problems: (1) Natural mortality and seasonal development as they influence control studies; (2) the effect of population density on kill; and (3) the relative susceptibility of different developmental stages. On the physical-chemical aspects of the emulsion studies three reports have been completed, one covering characteristics of fish-oil soap, one dealing with the properties of dilute emulsions, and one covering general methods and emulsion preparation.

One of the important undertakings of the year has been the completion and equipping of the laboratory at Whittier, Calif., for necessary work particularly in the citrus field. This laboratory was made possible by the interest of the citrus industry in California which financed its construction following special plans prepared by the bureau for the work to be undertaken. It is a 3-story structure, is equipped with refrigeration plant, constant-temperature rooms, and other special features, and is provided with 2 acres of land for experi-

mental plots. The major projects which are now under work at this laboratory concern the determination of more efficient methods of control, particularly of important citrus scale insects, both by fumigation and by spray applications. This laboratory, however, will be headquarters for practically all of the work of southern California in relation to citrus and other subtropical insects, including bulb insects.

INSECTS AFFECTING FOREST AND SHADE TREES, INCLUDING THE GIPSY MOTH AND THE BROWN-TAIL MOTH

The work in this field has been continued, as formerly, under the direction of F. C. Craighead.

WESTERN BARK BEETLES

Epidemics of the western pine beetle, which started in 1924 in the pure yellow-pine stands of northern California and caused a loss of 670,000,000 board feet of stumpage on 320,000 acres during the five succeeding seasons, underwent a sharp decline in 1929. The volume of yellow pine killed during the season of 1929 was 80 per cent less than in 1928. However, even with this reduction the 1929 losses were three and one-half times as great as those which occurred in 1923, the season before epidemic conditions started. The improvement was apparently due to better growth conditions in the forest during the season of 1928 and to a great increase during the same season in the number of natural insect predators of the beetle. This decline from natural causes was not general, however, as in the southern part of the Sierras the season of 1929 was marked by a decided tendency toward an increase of this insect.

Control operations during 1929 in California were financed mainly by owners of private timber. One company treated 2,320,000 board feet on an area of 20,000 acres in Modoc County. This control campaign was combined with salvage logging of the infested timber and will be followed in the near future by logging of the more susceptible green timber on the area. This type of selective logging is something of an innovation in dealing with bark-beetle infestation and is designed to save, through utilization, reserves of merchantable mature timber by manufacturing into lumber those trees which are apt to be killed by the beetles.

In southern Oregon the decline in the losses of western yellow-pine timber from the activities of the western pine beetle, which was first noted in the fall of 1928, continued during the season of 1929. The destruction of timber dropped to less than half of that in 1928. This was largely due to an improvement in moisture and growth conditions throughout the forested area. In spite of the natural improvement in conditions the Forest Service, the Indian Service, and private timber-owning corporations continued to combat the pine beetles with artificial control measures, concentrating their efforts on areas which had not responded readily to the natural decline. Approximately \$56,000 was spent in this work.

A survey was also made of the lodgepole-pine stands of Crater Lake National Park, Oreg., which have been suffering badly from attacks of the mountain pine beetle, and where control operations to protect the more valuable scenic and roadside areas around the

park headquarters have been conducted under the supervision of the bureau during the past four years. It was found that the control work had been very successful in reducing the losses in the treated areas, but that these areas were still menaced by epidemic centers in the surrounding country. This protective work will be continued by the park service during the coming year.

The surveys of sample plots distributed through the region, which were started in 1921, were continued through the year. It is expected that these surveys, covering, as they do, a wide area, will ultimately furnish valuable information on the correlation of bark-beetle epidemics and weather factors.

During the season of 1928 a small center of infestation of the mountain pine beetle was discovered in lodgepole pine in one of the important public camp grounds of the Sequoia National Park. In the fall of that season 44 infested trees were treated by the National Park Service. During the season of 1929 only three trees were attacked within the area. This project, though small, again demonstrated the feasibility of controlling this beetle where a complete clean-up of the infestation within the locality is accomplished. In this case there were no large areas of infestation within a distance of several miles to reinfest the treated area.

In the spring of 1929 approximately \$25,000 was spent by the Forest Service in conducting artificial-control measures within the white-pine stands of the Coeur d'Alene and Kootenai National Forests for the reduction of mountain pine beetle outbreaks. The results secured from these projects were very satisfactory. In October \$6,100 was spent on the Kootenai in an initial effort to test the practicability of fall control against the mountain pine beetle. The primary purpose of this project was to obtain a comparison of cost and effectiveness between fall and spring operations. The results secured were satisfactory and warrant further tests of fall control. It is thought that the better working conditions encountered in the fall will bring about a considerable saving.

Artificial-control measures for the suppression of an increasing outbreak of the mountain pine beetle in the lodgepole pine stands of the Targhee, Teton, and Wyoming National Forests were carried out by the Forest Service under the supervision of the Bureau of Entomology. The seriousness of this situation lies in the fact that these forests are continuous with those of the Yellowstone National Park and that an epidemic within the region would undoubtedly result in the destruction of the timber stands of the park. Some 40,000 trees were treated, and a satisfactory reduction in the infestation followed. However, all of the infested areas were not covered, and it was necessary to clean up the remainder last spring. In connection with this project the Forest Service has developed a rather novel method of treatment which is especially adapted to the open forests of that region. Inflammable oil is sprayed upon the infested portion of the tree trunk and the trees are burned standing. The heat which is produced from the charring of the bark is sufficient to destroy the insect broods beneath. Surveys of the white-pine stands of northern Idaho and western Montana show that serious epidemics of the mountain pine beetle are developing. A large-scale control operation will be conducted on the Coeur d'Alene National Forest in the spring of 1930, which will be the largest

forest-insect control project ever attempted. Smaller projects of this nature will also be carried out on the Clearwater and Kootenai National Forests, as well as in the Glacier National Park.

Intensive studies on the mountain pine beetle in Montana have contributed toward a better understanding of the relationship of parasites and predators. From the information gained it is now known that control work conducted in the fall of the year contributes toward the preservation of the most beneficial of these parasites, and this may result in a uniform adoption of fall control instead of spring operations during which most of these parasites are destroyed. Studies to determine the effects of artificial control and to devise improvements, and to determine the relation which fire-scorched trees bear toward the building up of subsequent bark-beetle epidemics, have been continued during the year.

One phase of the investigations dealing with the western pine beetle has been centered upon the food materials which this insect utilizes in western yellow pine, and the changes in this material that render certain trees attractive to the beetle. This study will require further development before conclusions can be drawn; but it has already been found that definite chemical changes, which take place in materials in phloem after a tree is felled, make it attractive to the beetles. Similar conditions have been observed in slow-growing trees before they are cut, which apparently accounts to a large extent for the preference shown by the beetles for trees of slow growth.

Considerable progress has been made during the year in the study of the biology of those insects associated with the western pine beetle. One species, a clerid, has been definitely established as an important predator of the adult bark beetle and its larva. It has also been found that infested bark can be exposed to the sun so as to kill the western pine beetle by solar heat, but that at the same time the predators will escape by moving out of the bark and complete their development. It seems possible, therefore, to apply biological control by reducing the numbers of bark beetles, at the same time preserving the numbers of their predators. During the coming season it is proposed to make an actual test of this method of control on an experimental basis.

THE FIR ENGRAVER

This insect (*Scolytus ventralis* Lec.) during the past five seasons has caused widespread injury to white fir throughout the Sierra Nevada region. During the spring of 1929 an analytical study was made of the character of the damage on three mill-scale study plots on the Stanislaus National Forest. It was found that a high percentage of the trees which are top killed have been attacked by this insect, and that it was responsible for the complete killing of trees of small diameters. This is at present the most important insect pest of white fir on cut-over lands and will undoubtedly have to be reckoned with in the management of stands containing a high percentage of this tree.

THE SOUTHERN PINE BEETLE

Additional data were secured emphasizing the close relation which exists between climatic conditions and beetle abundance. In the Appalachian region, following a mild winter, the beetles were abundant

during the early spring of 1929, and a rather heavy emergence was anticipated. An unexpected excess in precipitation during April and May, amounting to 5.4 inches in some localities, and coming just as the beetles were emerging, resulted in their sudden disappearance, so that by June 15 hardly a beetle could be found. This was followed by a deficiency during July and August amounting to 3.34 inches around Asheville, N. C. Simultaneously reports of outbreaks began to come in as others were found in the surrounding forest. Many weakened, lightning-struck, or wind-thrown trees were found infested, and as a result beetles were attracted to surrounding trees and infestations were built up. Severe infestations were located in the Pisgah and Unaka National Forests. The largest outbreak occurred at Hot Springs, N. C., in the French Broad division of the Pisgah Forest. Here, during September, some 2,716 old-field pines were found attacked on an area of about 30 acres.

A large number of beetle-infested trees were injected with poisonous solutions to determine the possibility of controlling bark beetles by this method. Complete mortality of the broods was obtained with a number of chemicals when injected into recently attacked trees. The condition of the tree at the time of injection was found to be of the utmost importance. The injection had to be made before the blue stain, associated with the bark beetle, had extended into the sapwood. When blue stain was present injections with the same chemicals, using two to three times the strength of dosage, failed to give very satisfactory results.

THE LOCUST BORER

Studies relating to the control of the locust borer (*Cyrtene robiniae* Forst.) by spraying were continued. Dilutions of solutions found effective the previous year were tried and were highly successful, as a result of which the cost of application has been lowered. Arsenical sprays, orthodichlorobenzene emulsion, orthodichlorobenzene and kerosene, and a paradichlorobenzene-pine-tar emulsion were used.

THE PINE TIP MOTH

Studies were continued on the parasites of the pine tip moth in the extensive Forest Service plantations at Halsey, Nebr., where this pest has been seriously retarding the growth of young pine trees for the last 20 years. *Campoplex frustranae* Cushman, a parasite introduced from Virginia in 1925, showed a continued increase and is now getting the tip moth under control. During the season of 1929, in the vicinity of its original release, parasitism amounted to about 82 per cent, four-fifths of which was due to this introduced species. Rearings showed the parasite to have reached a point in numbers above that of the host. The reduction in the number of infested tips and the benefit to the trees were very noticeable, only 33 per cent of the terminal shoots of yellow pine being infested as compared to about 90 per cent in previous years, and many of these trees had normal terminal shoots for the first time in many years. The parasite has spread satisfactorily and reached the limits of the plantation some 4 or 5 miles distant, where it will take several years for it to build up in sufficient numbers to bring about control.

THE WHITE-PINE WEEVIL

Cooperative studies on the white-pine weevil begun in 1924 with Harvard Forest and the Northeastern Forest Experiment Station were brought to a close in 1929 with the publication of the results of this work as Technical Publication 28 of the New York State College of Forestry, Syracuse, N. Y. Considerable new information on the biology of the insect is given and practical methods for growing white pine so as to avoid injury by this serious pest are described. Permanent sample plots laid out during these studies will be kept under observation for a number of years in order to check finally under actual growing conditions the ultimate effectiveness of the practices recommended, and to secure data for further correlation on the annual prevalence of the injury and seasonal conditions.

THE LARCH SAWFLY

The study of the larch sawfly has been continued during the year in the Lake States region, both in the vicinity of Ann Arbor, Mich., and in and about Itasca Park, Minn., through cooperation of the School of Forestry, University of Michigan, with S. A. Graham acting as agent. Some new biological information has been obtained. It has been found that insects which have suffered from scarcity of food during the larval period do not produce so large a number of eggs in the adult stage as do those that are well fed during the developmental stages; also, that the number of eggs laid by a female depends to a considerable degree upon the stage of development of the tamarack at the time of oviposition. Unless the new growth is one-half inch or more in length the sawflies refuse to lay their eggs even though they may die without ovipositing. The number of eggs laid increases in proportion to the length of the new growth until a length of about 6 centimeters has been reached, but after this point there seems to be no further increase.

The permanent sample plots were examined as in previous years. It is hoped that these examinations can be continued for some years to come to obtain information on the effect of defoliation and annual abundance of the insects. The growth appears to be reduced in direct proportion to the degree of defoliation. The curves representing the annual increment in the various groups follow lines which would naturally be expected, except in those trees which were completely defoliated for three years in succession. These show a considerable acceleration of growth the first year of defoliation, followed by a rapid decline, and death at the end of the third year.

THE BRONZE BIRCH BORER

Study of this insect initiated two years ago in cooperation with the Northeastern Forest Experiment Station and the University of Michigan was carried on in New Hampshire last year. One important point was brought out by these studies; that is, the apparent importance of environmental factors and the shoe-string fungus. It appears that the death of the birches following logging operations can be attributed entirely to *Agrilus*, but that the changes in soil temperature and moisture, and the shoe-string fungus (*Armillaria*), may be equally or more important factors than *Agrilus*.

INSECTS AFFECTING FOREST PRODUCTS

In cooperation with the termite investigations committee of the University of California, additional preservatives were placed under test at Panama during 1929 and 1930, in the long-time tests of wood-preservative treatments for both crude and finished forest products, and poisons for wood pulp and fiber products to prevent insect attack were also tested. The international termite-exposure tests, in cooperation with the Forest Products Laboratory, begun last year, have already furnished interesting results, reports from government officials in South Africa, Hawaii, and Panama showing a remarkable uniformity in at least preliminary results, considering the different conditions of exposure. The termite-proof buildings constructed of treated timber, as a supplement to these wood-preservative tests, are still proving satisfactory. Tests of mortars for foundation walls are being continued at Urbana, Ill., and Cleveland Park, Washington, D. C., in cooperation with the University of Illinois and the United States Bureau of Standards, to determine the best type of mortar to prevent entrance of termites through the foundation walls.

By the advice of the Bureau of Entomology, provisions to prevent termite attack have been included in mandatory city building codes in various cities in continental United States, as well as in the Canal Zone, Panama, and the Territory of Hawaii.

A film strip to illustrate graphically Department of Agriculture Leaflet 31 has been prepared and is available for the use of State entomologists in demonstrating how to render buildings termite-proof.

A publication has been issued by the National Committee on Wood Utilization advocating the retail sale of treated timber and its greater use in the construction of buildings. In this the Bureau of Entomology has contributed a chapter on wood-destroying insects.

Wooden articles, such as gunstock blanks, in storage at large arsenals in Illinois, Pennsylvania, and Massachusetts, were inspected at the request of the War Department, to prevent accumulative damage by powder-post beetles. The War Department requests that in the future such inspections be made by the Bureau of Entomology every two years.

The Bureau of Entomology has recommended dry Paris green as a remedy for the nonsubterranean termites which have been killing large numbers of tea trees in Ceylon. This method has proved very effective in saving the trees.

SHADE-TREE INSECTS

As in former years, the activities under the shade-tree insect project have necessarily been confined largely to the dissemination of information. Each year the demand for this service increases and the general aid through correspondence has been supplemented by radio talks, newspaper articles, and timely articles in other popular periodicals. A small increase for the coming fiscal year will make it possible for the bureau to extend its efforts in these problems to California and other States of the extreme West.

GIPSY MOTH AND BROWN-TAIL MOTH

FOREIGN WORK

The foreign work has included field investigations in Yugoslavia, Hungary, and Poland, biological studies on certain parasites of the gipsy moth and the satin moth, and the shipment of parasites from these central European countries to the gipsy-moth laboratory at Melrose Highlands, Mass. Two entomologists have conducted this work, with headquarters at Budapest, Hungary. About 100,000 parasites were sent during the summer of 1929 from the countries mentioned. Most of the parasites were various species of tachinid flies. About 4,100 cocoons of a species of *Meteorus*, bred from the satin moth, were received, and the adults emerging from these were liberated in New England.

Of the 30,000 cocoons of the hag moth (*Cnidocampa flavesceus* Walk.) received from Japan early in the spring of 1929, 6,190 adults of *Chaetexorista javana* B. and B. emerged, and 4,547 adults were liberated in the vicinity of Boston. There are on hand at the gipsy-moth laboratory at the present time 779,000 cocoons of *Cnidocampa flavesceus*. At the time this report was being prepared the parasites had not emerged from this material, but dissections indicated parasitism of about 25 per cent.

Investigations are being conducted in Sweden and other northern European countries to locate an infestation of *Phyllotoma nemorata* Fall., a sawfly that was introduced into Maine and has spread into New Hampshire and Massachusetts. The object is to secure parasites for introduction into those States.

STUDIES AND COLONIZATION OF PARASITES AND PREDATORS

During the fiscal year over 3,125,000 parasites have been liberated in the field, about 2,900,000 of these being *Anastatus disparis* Ruschka. One of the important liberations in large numbers in 1930 was the fly *Phorocera agilis* R. D., from overwintering material received from Europe in the late summer of 1929. Liberations were made of fertilized females and of gipsy-moth larvae upon which eggs had been deposited by fertilized females. This species was recovered in 1929 at a point where it was colonized in 1928, indicating that success has been attained in establishing this parasite after the attempts of several years.

The tachinid *Sturmia inconspicua* Meig., a parasite of sawflies and the gipsy moth, was recovered in 1929 in the same locality where it was liberated in 1928. *Chaetexorista javana* also was recovered in the late summer of 1929 in dissections of host material collected where the flies had been liberated earlier in the season, indicating that this species also is established. Records for 1930 will further verify this recovery.

Of the old-established parasites of the gipsy moth, *Anastatus disparis* Ruschka, *Ooencyrtus kuvanae* Howard, *Sturmia scutellata* R. D., and *Compsilura concinnata* Meig. show an increase over the previous year. *Calosoma sycophanta* L., the predatory beetle, has also increased generally.

The parasitism in the winter webs of 1929-30 of the brown-tail moth showed a general increase over that of the previous year. The

parasites contained in these stages are *Compsilura concinnata* Meig., *Meteorus versicolor* Wsm., *Zygobothria nidicola* Towns., and *Apanteles lacteicolor* Vier. Adults of *Eupteromalus nidulans* Foerster were also found to be more abundant in the hibernating webs of the brown-tail moth, and this is partially explained by its increased parasitism of the satin moth in the same locality. The parasitism obtained from the full-grown larvae of the brown-tail moth in 1929 was considerably less than that obtained the previous year.

The Calosoma beetle traps were tried on a rather large scale during the season of 1929, when a total of 17,332 were collected in fourteen $\frac{3}{4}$ -acre plots; 2,576 traps were placed out, which indicated an average of 1,175 beetles per acre, or 6.7 per trap. An average of 174.6 traps were placed out to the acre. The largest number of beetles obtained in 1 acre was 4,220. Each trap in this area collected 22.9 beetles during the season.

The beetles were used for recolonization purposes in central and western Massachusetts to study their effect in new territory where the host infestation is light but increasing, and some were sent to other States, as follows: 2,000 to Raton, N. Mex., to be colonized as an enemy of the New Mexico range caterpillar; 300 to Alamogordo, N. Mex., to be colonized as an enemy of the fir tussock moth; 200 to Seattle, Wash., to be colonized as an enemy of the satin moth.

BACTERIAL AND FUNGUS DISEASES

An attempt was made in 1929 to recover the bacterial disease of the gypsy moth *Streptococcus disparis* Glaser, but with negative results. Studies were conducted at the same time of the wilt disease of the gypsy moth, which was generally prevalent and effective. An attempt is being made in 1930 to again introduce the Japanese gypsy-moth fungous disease of the family Entomophthoraceae. Studies of the fungous diseases of the satin moth, namely, (*Sporotrichum*) *Beauveria globulifera* Speg. and *Isaria* sp., were conducted during the season of 1929 to establish the status of these fungi, which are both parasitic and saprophytic on this host.

ATTRACTANTS

The attraction experiments with the gypsy moth are being continued. These consist of attempts to find a better extract than benzol, xylol, or gasoline for the preservation of female genitalia which are later exposed in the field to attract males. A limited use has been made of this method in the field as a check on scouting work.

INSECTICIDES

Spraying investigations with lead arsenate and fish oil used as a sticker were conducted in 1929 in eighteen $\frac{1}{2}$ -acre plots in heavily infested woodland. Half of the plots were treated with lead arsenate alone and the other half with lead arsenate-fish oil mixtures and sprayed at different periods. The results indicated that 4 pounds of lead arsenate to 100 gallons of water, with 4 ounces of fish oil added to each pound of poison, was effective for the control of larvae in the earlier stages and even gave a good degree of control

for the later stages; but for late spraying, when the larvae were in the fourth or later stages, the results indicated that 5 pounds to 100 gallons of water was more effective.

Some tests were made during the year to determine the quantity of poison deposited on the leaves in woodland spraying and that falling on the ground. Two plots of 1 acre each were sprayed, and these indicated that 35.4 and 21.1 per cent, respectively, of the poison fell on the ground and 64.6 and 78.9 per cent was deposited on the foliage. From these two plots the quantity of foliage per acre was computed from samples after analysis of the lead arsenate was made, indicating that the first plot contained 5 acres of foliage and the second plot 8.3 acres, an average of 6.65 acres for the two plots.

Experiments were continued during the year in controlling the satin moth on Carolina poplars; these being sprayed with 4 and 5 pounds of lead arsenate to 100 gallons of water, with fish oil added as an adhesive. A dosage of 5 pounds to 100 gallons, to which fish oil was added, proved to be the more reliable in that it was desired to have the poison remain on the foliage from June, at the time the spring generation of larvae was feeding, till July and August, when the newly hatched larvae from the next generation fed before spinning cocoons for hibernation later. The tests showed that as an average only 13 hibernating larvae per square foot were found in burlaps used as traps on the trunks of the sprayed trees, against 530 hibernating larvae per square foot in burlaps on the check trees. A manuscript has been prepared setting forth these results in detail.

Dusting experiments have been conducted during the year with the idea of developing a sticker for poison dusts. Twenty-five dust mixtures containing lead arsenate or calcium arsenate as the arsenical were tested. Eleven of these mixtures gave promise of greater adherence than lead arsenate alone. Some of these were:

- Lead arsenate, 80 per cent; bentonite, 20 per cent;
- Lead arsenate, 80 per cent; ferric oxide, 20 per cent;
- Lead arsenate, 50 per cent; activated carbon, 50 per cent;
- Lead arsenate, 83 per cent; fish oil, 10 per cent; water, 7 per cent;
- Lead arsenate, 20 per cent; bone black, 80 per cent;
- Lead arsenate, 70 per cent; calcium chloride, 20 per cent; fish oil, 10 per cent.

Foliage-injury tests with arsenicals were continued during the season of 1929. These showed that injury took place much more readily from the under surface of the leaf and that moisture was necessary. A histological study of injured and uninjured leaf tissue was begun, which indicated that the arsenical penetrated through the cuticle instead of the stomata of the leaf. A mixture of 2 parts lead arsenate, 3 parts lime, and 3 parts ferrous sulphate gave promise of decreasing the solubility of the arsenic, and as a spray it adhered as well as or better than lead arsenate alone.

Toxicity experiments were conducted in 1929 with gipsy-moth larvae in which lead arsenate, calcium arsenate, and white arsenic were used. Each of the arsenicals gave a different toxicity ratio, depending in part on the percentage of arsenic which broke down in the digestive tract. The possibility of an enzyme acting on the arsenical was suggested.

Defoliation by the brown-tail moth was extensive in southeastern New Hampshire and a small portion of southwestern Maine in 1929,

STATUS OF MOTHS

as for several years past. A rough survey of this area indicated that a total of 161½ acres was defoliated, 71½ being in New Hampshire and 9 in Maine. Apple and wild-cherry foliage in this area was heavily fed upon. In addition to this several local infestations of small areas were known to exist in the coastal region of Maine and the eastern section of Massachusetts.

The acreage affected by the gipsy moth in New England in 1929, as estimated by employees of the Plant Quarantine and Control Administration, in cooperation with the States concerned, is as follows: 171,107 acres had from 1 to 50 per cent defoliation and 380,026 acres had from 50 to 100 per cent defoliation. Acreage affected in 1929 showed a considerable increase over that affected in 1928, a large proportion of this increase being in New Hampshire.

INSECTS AFFECTING STORED PRODUCTS

The investigations of stored-product insects have been conducted, as formerly, under the direction of E. A. Back.

NEW GRAIN FUMIGANT

The outstanding feature of the work with insects affecting grain and grain products has been the development of a new method of fumigating wheat in large terminal elevators. It is gratifying to report this distinctly new addition to our knowledge of insect control in bulk wheat at a time when grain elevators the country over are filled to capacity with a crop showing considerable weevil infestation.

In last year's report reference was made to the discovery of the value of ethylene oxide as a fumigant and to the fact that the mixture of certain fumigants with carbon dioxide enhances their insecticidal value. The insecticidal value of ethylene oxide was first discovered by R. T. Cotton, of the Bureau of Entomology, and R. C. Roark, of the Bureau of Chemistry and Soils, who published an account of their experiments with it in 1928.² Doctor Cotton and H. D. Young, of the Bureau of Chemistry and Soils,³ found that by mixing carbon dioxide with ethylene oxide the toxicity was considerably increased and the fire hazard reduced or eliminated according to the proportion of carbon dioxide used. Further tests by E. A. Back, R. T. Cotton, and G. W. Ellington, all of the Bureau of Entomology,⁴ indicated the desirability of using at least 7 pounds of carbon dioxide with 1 pound of ethylene oxide. Jones and Kennedy,⁵ of the Bureau of Mines, found that the vapor formed by a mixture of 7.15 parts by weight of carbon dioxide with 1 part of ethylene oxide was noninflammable.

For some years the Bureaus of Entomology and Chemistry and Soils have been searching for a fumigant suitable for use in the

² COTTON, R. T., and ROARK, R. C. ETHYLENE OXIDE AS A FUMIGANT. *Indus. and Engin. Chem.* 20:805. 1928.

³ ——— and YOUNG, H. D. THE USE OF CARBON DIOXIDE TO INCREASE THE INSECTICIDAL EFFICACY OF FUMIGANTS. *Ent. Soc. Wash. Proc.* 31:97-102. 1929.

⁴ BACK, E. A., COTTON, R. T., and ELLINGTON, G. W. ETHYLENE OXIDE AS A FUMIGANT FOR FOOD AND OTHER COMMODITIES. *Jour. Econ. Ent.* 23:226-231. 1930.

⁵ JONES, G. W., and KENNEDY, R. E. EXTINCTION OF ETHYLENE OXIDE FLAMES WITH CARBON DIOXIDE. *Indus. and Engin. Chem.* 22:146-147, illus. 1930.

treatment of stored grain. On account of fire hazard, excessive cost, ineffectiveness, toxicity to man, or deleterious effects on grain the fumigants in general use up to the present time have not been entirely satisfactory and the operators of grain elevators have had to resort to handling the grain in order to keep it in condition.

With the crowding of all terminal elevators during the past season with wheat, much of which showed signs of weevil infestation, the problem of developing a fumigant that could be depended upon became acute, and the ethylene oxide mixture was given a trial, the results of which were so gratifying that this mixture was used to fumigate several million bushels of wheat, likewise with excellent results.

Attempts were made to introduce the fumigant by applying it directly into the stream of wheat as the bins were being filled. In one instance the two gases were applied directly from cylinders, the materials being conducted through separate tubes leading into the top of the bin; in the other instance the ethylene oxide was mixed with "dry ice" (solid carbon dioxide) and the mixture poured into the grain as it entered the bin.

The use of dry ice has proved to be the most satisfactory method. In the preliminary tests 1 pound of ethylene oxide was used with 7 pounds of the dry ice and the dosage was figured on the basis of 2 pounds of ethylene oxide per 1,000 cubic feet of bin space. This dosage killed from 85 to 100 per cent of the weevils in concrete, steel, and wooden bins, some of which were closed whereas others were open at the top. The results of preliminary tests indicated the necessity for an increase in dosage, hence in subsequent fumigations 3 pounds of the ethylene oxide per 1,000 bushels of wheat was used. It was also decided to change the mixture of dry ice and ethylene oxide from a 7-to-1 ratio to a 10-to-1 ratio, so that the resulting product has a consistency resembling snow instead of being liquid.

Of the many fumigations conducted with the dry ice and ethylene oxide 10-to-1 mixture at the rate of 3 pounds of ethylene oxide or 33 pounds of the mixture per 1,000 bushels of grain, all but two have shown a 100 per cent kill, both in the planted test lots of insects and in the composite samples of wheat drawn from the bins. Of the two exceptions, one showed a 98.7 per cent kill and the other a 98.1 per cent kill.

The method of applying the ethylene oxide-dry ice mixture has been developed as a result of cooperative work between members of the Bureaus of Entomology, Chemistry and Soils, and Agricultural Economics, of the United States Department of Agriculture, the grain inspection department of the New York Produce Exchange, and the manufacturers of ethylene oxide.⁶ Through the courtesy of Laurel Duval, chief grain inspector of the New York Produce Exchange, members of the Department of Agriculture were enabled to observe the results of several commercial fumigations conducted by him with the ethylene oxide and dry ice involving the treatment of several million bushels of wheat.

Briefly, the process consists of mixing together ethylene oxide, drawn as a liquid from steel cylinders, and dry ice in large pails and

⁶ BACK, E. A., COTTON, R. T., YOUNG, H. D., and COX, J. H., THE USE OF THE ETHYLENE OXIDE-CARBON DIOXIDE MIXTURE FOR TREATING STORED GRAIN. 10 p., illus. 1930. (Multi-graphed.)

introducing the mixture into the wheat as it is run into the bin. The mixture is carried down with the grain and is well distributed through it. It soon changes to a vapor that kills all weevil life.

As has been previously indicated, dry ice is really carbon dioxide in solid form. It is a white solid, easily crushed, and has a temperature of -110° F. On exposure to air it slowly changes from a solid to a vapor. For fumigation purposes a special type of dry ice is used that is not compressed so much as the ordinary type. It has the consistency of chalk and is very easily crushed. It is delivered in insulated boxes that prevent excessive evaporation. It is prepared for use by being broken into small pieces with a sledge and ice pick, and shoveled into garbage pails that hold about 70 pounds each. Since dry ice has a temperature of -110° F., it should not be handled with bare hands: if handled carelessly it is likely to blister the skin.

The ethylene oxide is poured over the crushed dry ice at the rate of 1 pound to 10 pounds of the dry ice. The mixture should be stirred a little so that all liquid will be taken up by the dry ice. To prevent unnecessary loss by evaporation, the materials should be mixed only as needed.

Once made, the mixture should be carried to the bin floor of the elevator and applied to the wheat stream without delay. It can be applied by shoveling it into the grain stream as it is about to enter the bin, or with a machine regulated to feed the mixture into the bin, by means of a worm drive. A dosage of 33 pounds of the mixture per 1,000 bushels of grain has been found to give excellent results. If the wheat is run into the bin at the rate of 12,000 bushels per hour, a 66-pound batch of the fumigant should be fed into the grain stream during every 10-minute period.

In order to counteract leakage at the bottom and top of a bin, the dosage for the first 1,000 bushels and the last 500 bushels is made proportionately greater than that for the rest of the bin. For example, in a 15,000-bushel bin, 66 pounds of the mixture is used for the first 1,000 bushels and 33 pounds of the mixture for the last 500 bushels. The dosage for the rest of the bin should be made slightly less than 33 pounds of the mixture per 1,000 bushels of grain in order to have an average of 33 pounds per 1,000 bushels for the entire bin.

Where the bin is open at the top, it is desirable to cap off the grain with a layer of the ethylene oxide-dry ice mixture in order to insure a perfect kill in the upper layer of grain.

When the fumigant is applied by shoveling the ethylene oxide-dry ice into the grain stream, the operator unavoidably inhales more or less of the gas. Inhaling small quantities of the gas is not harmful to the operator, but prolonged exposure to the fumes is likely to cause severe nausea, particularly in the presence of heavy grain dust. It is, therefore, well to assign two men to the task of shoveling, so that they can alternate in the application of each batch of the mixture. Should an employee become nauseated from too long an exposure to the fumes, the discomfort is only temporary, and no further ill effects need be feared.

The fumigation of wheat as above described does not appear to affect the milling or baking qualities of the wheat. No odors have been detected in the fumigated wheat samples. Germination tests

indicate that the fumigation of bulk wheat with the mixture does not materially affect its viability. However, it is unwise to fumigate small quantities of wheat intended for seed.

FUMIGANTS FOR VARIOUS STORED PRODUCTS

The work of developing new fumigants and of adapting them to commercial practice has been continued. Aside from the development of a successful method of fumigating wheat in terminal elevators, other experiments with ethylene oxide, alone and in combination with carbon dioxide, have been conducted, particularly in relation to insect control in such food commodities as nut meats, candies, dried beans, rice, breakfast cereals, flour, and cartoned goods and in such manufactured articles as upholstered furniture.

Ethylene oxide was used successfully in grocery stores, in hospital food-supply rooms, in fumigable storage bins in dried-fruit establishments, in work rooms, and candy establishments, and for treating cured tobacco. The Navy Department fumigated with excellent results over 10,000 pounds of sacked rice infested with the rice weevil (*Sitophilus oryzae* L.) in a quartermaster's depot of recent construction. In a house basement ethylene oxide proved effective against the webbing clothes moth (*Tineola biselliella* Hum.), the furniture carpet beetle (*Anthrenus vorax* Casey), the confused flour beetle (*Tribolium confusum* Duv.), and the rice weevil. In tight fumigating rooms no difficulty was experienced in killing tremendous numbers of the saw-toothed grain beetle (*Oryzaephilus surinamensis* L.), and the confused flour beetle in 1, 2, and 3 pound cartons containing such cereal products as farina, rolled oats, and corn flakes, or in killing the cadelle (*Tenebroides mauritanicus* L.) and the confused flour beetle in stacks of 96-pound sacks of wheat flour. No living specimens of the webbing clothes moth or the furniture carpet beetle could be found in heavily infested upholstered furniture treated in a modern fumigation vault.

Experiments indicate that nut meats of all sorts can be fumigated with ethylene oxide alone, or in combination with carbon dioxide, without taking on an odor or flavor detrimental to their immediate sale. Almonds, English walnuts, peanuts, pecans, and cashew nuts were fumigated and were pronounced by nut experts to be free from foreign odors and tastes.

Experiments indicated that when the temperature of the stocks and the fumigating room ranged from 75° to 78° F., rice, beans, dried fruits, and nut meats can be fumigated as described below.

RICE

Polished rice can be treated either in bulk or in sealed cartons. Rice does not adsorb much gas, and comparatively small quantities of the ethylene oxide are very effective against the insects that attack it. Bulk rice is more easily fumigated than package rice since more gas is required to penetrate the tightly sealed cartons. The dosages recommended are based on tests with adults and larvae of *Tribolium confusum*, larvae of the Indian meal moth (*Plodia interpunctella* Hbn.), and larvae of *Tenebroides mauritanicus*, as they are more resistant to the vapors of ethylene oxide than other rice-infesting

insects. The rice weevil, which is regarded by many as the worst insect pest of rice, is very susceptible to this gas, and may be killed in as short a time as 10 minutes. In atmospheric fumigation, bulk rice can be freed of insect life by the use of 1 pound of ethylene oxide per 1,000 cubic feet of space during an overnight fumigation. Under similar conditions rice in cartons requires a dosage of 2 pounds per 1,000 cubic feet in order to get a perfect kill. In vacuum fumigation ethylene oxide should be used in the proportion of 3 pounds per 1,000 cubic feet for 1 hour, or 2 pounds per 1,000 cubic feet for 2 hours, for treating bulk rice; and 3 pounds per 1,000 cubic feet for $2\frac{1}{4}$ hours, or 2 pounds for 3 hours, for rice in cartons. When used in combination with carbon dioxide, 2 pounds of ethylene oxide per 1,000 cubic feet for $1\frac{1}{2}$ hours, or 1 pound per 1,000 cubic feet for three-fourths of an hour, is sufficient for the treatment of bulk rice, and 3 pounds per 1,000 cubic feet for three-fourths of an hour, or 2 pounds per 1,000 cubic feet for 1 hour, is required for the treatment of rice in cartons.

BEANS

Dried beans of all types may be fumigated either loose or in bags. For atmospheric fumigation 2 pounds of ethylene oxide per 1,000 cubic feet of space for an overnight exposure will kill all bean weevils present whether the beans are in bulk or in sacks. For vacuum fumigation 3 pounds of ethylene oxide alone per 1,000 cubic feet for 1 hour, or 2 pounds per 1,000 cubic feet for 2 hours, will give a perfect kill. In combination with carbon dioxide, experiments indicate that it is necessary to use 2 pounds of ethylene oxide per 1,000 cubic feet for one-half hour, or 1 pound per 1,000 cubic feet for 1 hour. Beans intended for seeding purposes should not be fumigated with ethylene oxide.

DRIED FRUIT

For the treatment of dried raisins, either in bulk or in cartons, 1 pound of ethylene oxide per 1,000 cubic feet of space will give satisfactory results in an overnight atmospheric fumigation, provided an air-tight vault is used. Double the quantity of fumigant should be used if the vault is not absolutely air-tight. In vacuum fumigation 2 pounds of ethylene oxide per 1,000 cubic feet of space for $1\frac{1}{2}$ hours, or 3 pounds per 1,000 cubic feet for 1 hour, are necessary to give a perfect kill in both bulk and packaged raisins. In combination with carbon dioxide 2 pounds of ethylene oxide per 1,000 cubic feet for one-half hour, or 1 pound per 1,000 cubic feet for $1\frac{1}{2}$ hours, is sufficient.

NUT MEATS

Experiments have shown that nut meats adsorb a much larger quantity of gas than most other foodstuffs and consequently require a correspondingly greater dose to insure a perfect kill. For the fumigation of raw, shelled peanuts or other nut meats, a dosage of 3 pounds of ethylene oxide per 1,000 cubic feet for an overnight exposure under atmospheric conditions is required. If used with carbon dioxide, only 2 pounds of ethylene oxide per 1,000 cubic feet is required. In vacuum fumigation 3 pounds of ethylene oxide per 1,000 cubic feet in combination with 28 pounds of carbon dioxide will

give a perfect kill in two hours. Ethylene oxide alone is not recommended for the fumigation of nut meats in vacuum owing to the excessive quantity that would be required to effect a kill.

CARBON DIOXIDE AS AN AID IN THE FUMIGATION OF HIGHLY ADSORPTIVE COMMODITIES

When the time element in fumigation work is of importance, as in some commercial establishments with a large daily output, vacuum fumigation is necessary. By this method of fumigation results may be obtained in from 1 to 2 hours that would require from 12 to 14 hours under atmospheric methods. But to get these quicker results, a correspondingly larger quantity of fumigant must be used. It was found, for example, that carbon disulphide will give a satisfactory kill in an atmospheric fumigation vault at a dosage of 2 pounds per 1,000 cubic feet of space for 24 hours, whereas it is customary for commercial fumigators to use as high as 40 pounds per 1,000 cubic feet in vacuum fumigation. In an empty fumigation vault, within certain limits, the time required to kill a certain insect is in direct proportion to the dosage. However, if the vault is filled with merchandise, the factors of adsorption and absorption present problems that are difficult to overcome, as these factors are not constant but vary with the type of commodity being fumigated, with the fumigant used, and with the temperature. Experiments conducted in small vacuum tanks of 8.7 and 21.76 liters capacity against *Tribolium confusum* gave interesting results at 72° F.

In an empty vacuum tank it required 2 ounces of chloropicrin per 100 cubic feet of space to give a 100 per cent kill of adults of *Tribolium confusum* in 2 hours. But when the tank was filled to capacity with raw peanuts it was impossible to kill 100 per cent in 2 hours even when a dose of 48 ounces per 100 cubic feet was used. In an endeavor to obtain a kill in 2 hours with a reasonable quantity of chloropicrin, tests were made with various mixtures of chloropicrin and carbon dioxide. After the customary 27 inches of vacuum was drawn the carbon dioxide was admitted to the tank, followed immediately by the chloropicrin. It was found that up to a certain point the more carbon dioxide used the smaller the quantity of chloropicrin required to give a kill. When used with carbon dioxide at the rate of 2.8 pounds per 100 cubic feet of space, 7 ounces of chloropicrin gave a 100 per cent kill of adult *Tribolium confusum* in 2 hours with the tank filled with raw peanuts. With 4.2 pounds of carbon dioxide per 100 cubic feet, 4 ounces of chloropicrin per 100 cubic feet gave a 100 per cent kill.

Experiments in an empty vacuum tank with 30-minute exposures at 72° F. indicated that the addition of carbon dioxide up to approximately the rate of 4.2 pounds per 100 cubic feet of space adds to the toxicity of chloropicrin in proportion to the quantity of carbon dioxide used. Higher percentages of carbon dioxide apparently do not increase the toxicity of chloropicrin beyond this point. To summarize the experiments briefly, a 100 per cent kill of *Tribolium confusum* was obtained in 30 minutes with 6.6 ounces of chloropicrin per 100 cubic feet when used alone; with 4.6 ounces of chloropicrin when used with 1.4 pounds of carbon dioxide per 100 cubic feet; with 2 ounces of chloropicrin when used with 2.8 pounds of carbon dioxide per 100 cubic feet; and with 1.28 ounces of chloropicrin when used with 4.2 or more pounds of carbon dioxide per 100 cubic feet of space.

Experiments with ethylene oxide indicate that this gas is not adsorbed or absorbed by nut meats to such an extent as is chloropicrin. In an empty vacuum tank ethylene oxide used alone at the rate of 3.2 ounces per 100 cubic feet of space gave a 100 per cent kill of adult *Tribolium confusum* in 2 hours at 72° F. In the tank filled with raw peanuts, it required 11.2 ounces of ethylene oxide per 100 cubic feet to give a 100 per cent kill in 2 hours. With the addition of carbon dioxide at the rate of 2.8 pounds per 100 cubic feet, 4 ounces of ethylene oxide gave a 100 per cent kill in 2 hours in the tank filled with peanuts. Larger quantities of carbon dioxide did not materially increase the toxicity of ethylene oxide.

Additional experiments with other highly adsorptive materials indicate that carbon dioxide can be used to advantage with other gases in the fumigation of many materials that it has hitherto been difficult or impractical to fumigate successfully.

HOUSEHOLD INSECTS

The work on household pests has been of a very general nature during the past year. Numerous experiments have been conducted to determine as far as possible from laboratory work the value of a number of so-called moth-proofing solutions. While no solution at present available to the public has proved itself capable of permanently or completely moth-proofing any fabric, laboratory results indicate that the better cinchona alkaloid solutions and those containing fluorine compounds are capable of imparting a moth resistance that is of practical value. To be of value they must be applied in such a manner that the fabric is thoroughly wet by them. The outstanding feature of the work with moth-proofing solutions is the cooperative work conducted with the Bureau of Chemistry and Soils in developing a solution that can be offered the public under a public-service patent. This has led to tests of different strengths of a rotenone dissolved in acetone which gave such gratifying results that a public-service patent was applied for in February, 1930.

Rotenone is one of the insecticidal constituents of Derris root, cubé root, and other tropical fish-poisoning plants. It is a white crystalline material of the formula $C_{23}H_{22}O_6$, with a melting point of 163° F. It is quite insoluble in water, is very slightly soluble in petroleum oils, slightly soluble in alcohol and ether, and readily soluble in chloroform, ethylene dichloride, and other chlorinated hydrocarbons.

Cloths treated with solutions containing 1 per cent and 2 per cent of rotenone dissolved in acetone were thoroughly protected against the ravages of the webbing clothes moth (*Tineola biselliella* Hum.), the furniture carpet beetle (*Anthrenus vorax* Casey), and the black carpet beetle (*Attagenus piceus* Oliv.), when they were confined in Petri dishes both with and without untreated cloths. Even 0.05 per cent solutions of rotenone in acetone gave excellent protection. It is hoped that this solution can be developed sufficiently to become available to the householder.

BEAN WEEVILS

The hearty support given the bureau in its investigation of bean and cowpea weevils in Merced, Stanislaus, and San Joaquin Coun-

ties, Calif., has continued during the year. The scope of the work has not changed. The nature of the investigation is such that it will be several years before a satisfactory conclusion can be reached as to the exact value of the present campaign in reducing the weevil population on the farms by a concerted attack upon storage conditions. It has been estimated by California officials that an infestation of more than 50 per cent has been reduced during the past two years to one of less than 4 per cent in many sections. It is admitted that the damage caused by weevils no longer assumes the major proportions of two years ago. This generally acknowledged practical result has been made possible only by the whole-hearted support given the bureau by California city, county, and State organizations.

FLOUR-MILL INSECTS

The flour-mill-insect project has been continued during the year, in part, in cooperation with the Kansas State Agricultural College. Preliminary investigation has indicated that air currents on ships transporting flour are capable of carrying flour-infesting insects from one part of a ship to another. This explains the importance of keeping all compartments of ships as free as possible from insects affecting flour lest infestation take place while a consignment is en route. Further investigation of railroad cars indicates the possibility that they may become a source of insect infestation through flour shipped in them from the mill to the port. It has been demonstrated that the heating of wheat sufficiently to kill insects will not injure the milling or baking qualities of flour made from the wheat. Continued study of the flour-mill-insect problem indicates that wheat brought into the mill for grinding brings with it insects that tend to offset the value of mill fumigations. It is believed that the heat treating of wheat just as it enters the mill will aid in eliminating this source of infestation of mills, and machinery satisfactory for such use of high temperatures is being installed and will be made a subject of observation. The use of mill sprays, and of different fumigants both in the mill at large and in the warehouse and fumigating vault, is still the object of continued research.

DRIED-FRUIT INSECTS

During the year the activities of this investigation were extended to the date industry in the Coachella Valley. Traps were placed on two ranches there, and the insects captured, mostly nitidulid beetles, were the same species as those which infest figs in the San Joaquin Valley. The Deglet Noor Date-Growers' Association decided to use ethylene oxide as a fumigant for their product as a result of experiments conducted.

The fig moth (*Ephestia cautella* Walk.) was present in large numbers in new-crop raisins, and the migrant larvae were very numerous, beginning in October, 1929. The infestation was heavier than in 1928, when the insect first appeared as an important pest of new-crop raisins. Growers and packers for the first time were quite generally concerned about infestation in their raisins, but the proposed systematic fumigations of all raisins, either on the ranches or upon delivery at packing plants, were found to be unnecessary.

The value of dusting sulphur as a possible repellent against the dried-fruit beetle (*Carpophilus dimidiatus* Fab.) and its allies was thoroughly tested on four ranches without beneficial results. Trapping of the beetles was continued in fig orchards, as during last year, to determine their relative abundance. Apparently because of the cold winter of 1928-29, the beetle population in fig orchards was low, fulfilling the indications of the results of trapping in the spring of 1929. The condition of the crop of Adriatic figs was much better than in 1927 and 1928, and there can be little question that this was a direct result of the decreased nitidulid-beetle population. Trapping in the spring of 1930 indicated that the beetles were considerably more numerous than in the spring of 1929.

It is gratifying to report continued progress in the installation by private firms of equipment making satisfactory fumigations of stocks possible. The bureau's efforts during the past three years have resulted in great improvement so far as infestation of figs by storage pests in packing houses is concerned. The use of ethylene oxide as a fumigant in the dried-fruit industry has increased.

An important phase of the investigation of dried-fruit insects has been the biological studies of the fig moth (*Ephestia cautella*), the dried-fruit beetles *Carpophilus hemipterus* L. and *C. dimidiatus* Fab., the moth *Aphomia gularis* Zell., and the hymenopterous parasite *Habrobracon juglandis* Ashm. The chocolate moth (*Ephestia elutella* Hbn.) and the moth *Aphomia gularis* were noted for the first time as pests of prunes. An ant, *Formica fusca argentata* Whirr., was observed preying upon fig-moth larvae near raisin stacks in the Fresno district.

Experiments with oil-treated raisins were conducted, but in no case did the results promise immunity of oiled fruit from insect attack, although it is probable that insect infestation of packed stock can be retarded by the oil treatment. The efficacy of a triple-sealed prune package was demonstrated by the exposure to infestation of a series of cartons, both with and without the outside wrapper or label.

Examinations of empty railway cars prior to loading with dried fruits were begun in December, 1929, and continued at intervals in order to secure information about the insects found in such cars. Empty sweat boxes, which sooner or later are returned to ranches from the packing house, were likewise examined at intervals to determine the extent to which insects in them might find their way back to ranches and contribute to the building up of infestation in new-crop fruit.

During the year five papers were prepared giving results of investigational work, 481 visitors were received at the laboratory at Fresno, 147 ranch visits were made, 203 packing-house calls were made, and about 15,000 passenger miles were traveled.

INSECTS AFFECTING MAN AND ANIMALS

This work has been conducted under the direction of F. C. Bishopp.

SCREW-WORM FLY AND OTHER BLOWFLIES

The utilization of flytraps for the control, under range conditions, of the screw worm and fleece worm is being further studied in a typical stock-range area in Texas. By locating a series of traps in carefully selected locations representing the various types of grazing

areas in that section, basic information is being obtained which should serve as an index to trap location and thus greatly increase the efficacy of the traps in catching flies. A wide variation in the number of flies caught in the different environments clearly shows the need of such investigations. In these specially located traps the number and sex of all injurious species are being determined and correlation studies made with reference to evaporation, as determined by atmometer readings, and to various other environmental factors. Fly trapping is being very widely employed by ranchmen, and the failure of such control efforts to reduce materially the number of screw worms and fleece worms on livestock further emphasizes the need of these fundamental studies.

Tests of a number of different types of small flytraps have been made in comparison with the conical trap developed by the Bureau of Entomology, and none of these has been found so effective as the conical trap. In addition, a new type of trap has been designed and tested. This is a large trap made to utilize the whole carcass of a cow as bait, to prevent the escape of flies which breed in it, and to encourage the breeding of parasites of the immature stages of the flies. While the true value of these large traps has not yet been fully established, their value with respect to convenience in servicing and as a means of disposing of carcasses is evident, and several ranchmen have installed them. Tests of baits of different kinds and quantities used under standard conical traps have been continued, but no satisfactory substitute for meat has been found.

The native parasites and predators of the blowflies have been given considerable attention. The life history, seasonal history, and host-species preference of the chalcid parasite *Brachymeria fonscolombei* Dufour have been studied. This species is given special attention because of its habit of attacking the flies in their larval stage. It has been found, however, to prefer the larvae of the sarcophagid flies to those of the more important economic species. Status studies still indicate that *B. fonscolombei*, the local larval parasite, may be of considerable economic value in the control of screw-worm flies in small carcasses. In 10 jars in one series an average parasitism of 96 per cent has been obtained, and in six series at one time an average of 88 per cent was shown. Releases of approximately 8,000 adult parasites in a certain pasture over a period of two months indicated that the percentage of parasitism increased much more in this pasture than that of the parasitism in pastures where no releases were made. *Mormoniella abnormis* Boh., the common pupal parasite at Uvalde, Tex., has not been shown to have a very considerable economic value. Three, and possibly four, other parasites have been reared from fly pupae but have not as yet been studied. It has been determined that some 15 to 20 insect predators have some value in the destruction of the several stages of flies that breed in flesh, and there are indications that some of these have considerable economic value.

CATTLE GRUBS

Investigations of cattle grubs have been continued along the lines indicated in the last report. Certain phases of the work have been carried on cooperatively with the Bureau of Animal Industry in the localities where area control is being tested. An inquiry into the

present distribution of the northern cattle grub shows this most destructive species to be present in Idaho, Washington, Utah, Minnesota, and West Virginia, States in which it was not previously known to occur. This species has also become more generally established in several of the Northern States, where it was previously found only in scattered localities.

Investigations of the areas of grub scarcity have been centered in the Red River Valley of Minnesota. The evidence collected there points to the operation of several controlling factors, particularly the heavy soil, the practically level terrain, and the seasonal distribution of rainfall. As the work has been done during two unusually dry years, however, the findings differ from the normal. In fact, cattle-grub infestations were found in the Red River Valley during the spring of 1930, a condition unheard of previously, but supporting the idea that rainfall, drainage, and soil factors are responsible for the normal absence of grubs in this section. A preliminary survey was made of the districts in Florida where cattle grubs do not occur. The territory of normal occurrence of the cattle grub was fairly well defined, but further studies of the factors responsible for this condition are needed.

Investigations of insecticides for use in destroying the grubs in the backs of the cattle were continued. Special attention has been given to the quantity of tobacco powder, nicotine dusts, and Derris required to give effective control. This work indicates that the use of 2 or more ounces of Derris powder per animal is necessary when the entire back of the animal is to be treated. In using nicotine-sulphate dust, better kills resulted when rather heavy applications of the dust were made to each grub than when a general but lighter application was made to the entire back of the infested animal. Tests were conducted to determine the toxicity incident to treating cattle with known quantities of nicotine preparations. In tests of previous years it had been proved that nicotine sulphate and free nicotine in dust carriers, as well as natural tobacco powders, are efficient larvicides for *Hypoderma* in cattle. No toxic effect on the host has been apparent from the quantities applied. The question arose as to whether a general application all over the back of an animal, when the animal is heavily infested, would result in toxicity to the host. The Bureau of Entomology and the Bureau of Animal Industry cooperatively conducted a series of tests to get some information on this point. In preliminary tests with a few animals it was found that free nicotine in inert dust, applied in the amount of 3 ounces of 2 per cent, did result in slight toxosis. Similar tests with nicotine sulphate in the same quantities revealed no such reaction in the host. After the preliminary tests were completed, more extensive applications were made with nicotine sulphate in inert dust. No poisoning of the host resulted.

SHEEP SCAB MITE AND GOAT LICE

Investigations of these important pests of sheep and goats were continued in cooperation with the Texas Experiment Station at Sonora, Tex., and at the Dallas, Tex., laboratory of the bureau. The ability of sheep scab mites to persist for months on a sheep without any external evidence of infestation was demonstrated in experimental animals.

Tests of insecticides for control of goat lice were continued, and certain fine grades of sulphur were found to effect complete destruction of all species of goat lice when applied thoroughly as a dip. These sulphur dips are not injurious to the mohair and are nonpoisonous to the goats. Although a single dipping gave 100 per cent control on experimental animals, in tests under range conditions a few lice were found to survive, thus making a second dipping necessary for eradication. An interval of 11 days between the two dippings is indicated as most effective.

EYE GNATS

Investigations of the biology and methods of control of the eye gnats (*Hippelates* spp.), initiated last year, were continued. While the exact conditions under which these gnats breed in nature has not yet been determined, it has been proved that they will breed freely in several different materials, such as excrement of man and animals, decaying meat, and fermenting vegetable matter. By the use of large numbers of field-recovery cages it has been shown that the gnats are breeding in the soil over wide areas. These tests indicate that the type of soil, the cultural methods employed, and the cover crops turned under have important bearings on the breeding of the pest.

Trapping of the gnats as a control procedure and to obtain accurate information on the seasonal occurrence and local distribution of the insects has received much attention. A simple and effective trap has been developed. Liver and urea have been found to make a very attractive bait. The use of traps decidedly reduces annoyance from the gnats, and since a large percentage of the gnats caught are gravid females it appears likely that some degree of control may be effected by systematic trapping.

MOSQUITOES

Studies of the food habits and natural ecology of the larva of *Anopheles quadrimaculatus* Say were continued at Mound, La., this year, being the third year of comparative observations to determine the environmental factors affecting the abundance of this species. Monthly records were made in a series of breeding and nonbreeding places to show the abundance of larvae, the quantity of protective material present, counts of the different genera of microscopic aquatic organisms per unit volume of water, and the hydrogen-ion concentration of the water. Parallel dissections of larvae were made to identify the food ingested under the recorded conditions, and correlative studies are being made of the accumulated data.

Laboratory tests with different species of legumes have been started to determine whether the adult *Anopheles* are able to feed and subsist on the nectar or juices of such plants. These were undertaken in view of the theory that malaria parasites are destroyed by the action of the chemical coumarin present in leguminous plants and that malaria is therefore absent in areas where legumes are extensively grown. The results so far have not shown the ability of *Anopheles quadrimaculatus* to feed on such plants.

Records of the comparative density of mosquito populations, which have been kept over a period of 11 years, showed a very large increase in the abundance of *Anopheles* during 1928 and 1929 over the previous four years, but the abundance was comparable to that during the four years from 1920 to 1923. This return to a more normal output of malaria mosquitoes from the breeding areas was apparently reflected in a marked increase of malaria among the tenant families during 1929.

Important information on the life history and habits of the pest mosquito *Mansonia perturbans* Walker has been derived from studies conducted at Zellwood, Fla. Contrary to the general belief, this mosquito appears to have several broods annually in that section. In Florida the water plant *Pontederia* appears to constitute the only species to which the larvae of this mosquito will attach and on which they will develop. This explains in part the restrictions in breeding areas of this mosquito, which have been noted previously.

BEE CULTURE

The work of the bee-culture laboratory has continued under the direction of James I. Hambleton, with headquarters at Somerset, Md.

BEHAVIOR OF BEES

In the work on artificial insemination of queen bees by the Watson method a glass pipette fitted with a glass plunger has been successfully used. Twenty-five to thirty per cent of the queens operated upon thus far with the original or the modified plunger have shown some degree of insemination. In previous years only virgins reared from naturally mated queens were used, but this year virgins from the F_1 generation of artificially inseminated queen bees are being tried as well. By modifying the California queen cage, as many of the treated queens as desired or convenient are now being kept in one hive, thus cutting down the number of bees and frames of brood required to test whether or not the queens are successfully inseminated. Drones of desired stock are being marked on emergence in an endeavor to determine the proper relative age at which to use drones. By buying mature drones from the South the season during which artificial insemination may be conducted is made from four to six weeks longer.

Studies of the biometric measurements of the honeybee have been continued. Physical characteristics other than length of tongue are being studied in an effort to establish a definite basis for distinguishing between the various races and strains of the honeybee.

During the year one article on the races of the honeybee was published by the department, and two articles on this topic were published outside the department. One article dealing with certain phases of the work on artificial insemination was also published outside the department.

The investigation on the relative stimulative efficiency of various regions of ultra-violet for the honeybee has been finished, and the results reported upon orally before the American Society of Zoologists at Des Moines, Iowa. A written report has also been prepared for publication.

Data obtained during the year on the variation in the flight of honeybees to an artificial source of nectar are being studied in conjunction with weather factors. Because of the necessity for making further improvements on the flight-recording instruments, apparatus to secure similar data at the field stations has not been installed.

Work has begun on the making of a motion picture depicting the behavior of bees in such activities as the collection of nectar, pollen, and propolis and in the building of comb.

In cooperation with the division of forage crops of the Bureau of Plant Industry, experiments have begun at Holgate, Ohio, in a study of the behavior of honeybees in the pollination of red clover. In these experiments honeybees will be confined to plots of red clover, and in other cases attempts will be made to determine the importance of other nectar-secreting plants in attracting the bees from the red clover. It is also planned to stimulate the bees artificially to work on red clover.

PHYSIOLOGY OF BEES

The investigation of the physiological effects of ultra-violet rays on the brood and adults of worker bees and on adult queen bees has continued. The results so far indicate that ultra-violet rays even in minimum quantities are detrimental to all stages of the brood, and thus far it has not been possible to give a beneficial exposure. In conjunction with the testing of queens treated with ultra-violet rays an experimental apiary has been established at New Windsor, Md., where the fecundity and the longevity of queens can be studied under commercial conditions.

An effort is being made to prepare a stain for permanently marking large numbers of adult bees. A method of marking would be a great asset in studying the flight of bees from individual colonies, and other problems of behavior and physiology.

Work on the longevity of package bees and queens is still in progress.

BEEKEEPING REGIONS IN THE UNITED STATES

The study dealing with the cost of honey production and apiary management in the Intermountain States, undertaken in cooperation with the Bureau of Agricultural Economics and State beekeeping specialists, has been continued. A multigraphed preliminary report showing the progress of the first year's work has been published. Unless the honey crop in the Intermountain States is decidedly abnormal the present season will probably conclude the work in that region which has been carried on during the past three years. A similar study has been begun in the white-clover belt of the Great Lakes area. Cooperators are keeping records in New York, Ohio, Indiana, Michigan, Wisconsin, and Minnesota. The work in this area will also be conducted cooperatively with the Bureau of Agricultural Economics and the State beekeeping specialists. Judging from the correspondence, much interest is being manifested in these studies. Beekeepers from other parts of the United States have asked that similar studies be inaugurated in their sections of the country. Beekeeping organizations in some of the foreign countries have also shown considerable interest in the results that are being obtained.

Phenological studies on the principal nectar-producing plants continue. This work is being conducted largely through correspondence and consequently progress is slow.

The bee-culture laboratory has been collecting for the Bureau of Chemistry and Soils samples of the principal honeys produced in the United States. Various investigations on honey are in progress in that bureau. In addition to the fine types of commercial honeys, samples are being collected of the principal so-called undesirable types of honey which are produced in commercial quantities, but which do not have a ready sale because they are off-flavor or off-color. An effort will be made to improve the qualities of these honeys and to use them in products where the remaining undesirable characteristics will not be objectionable.

DEMONSTRATIONS IN BEEKEEPING

As has been the custom during the past few years, it has been necessary, because of lack of funds and personnel, to refuse many invitations to participate in meetings of beekeepers' organizations. Several observation hives have been prepared and lent for school and laboratory use, and a number of short manuscripts, many photographs, and other educational material on bees have been furnished to schools, the press, and feature writers.

A catalogue has been completed listing all the beekeeping literature in the Department of Agriculture and the Library of Congress. This work has been done in cooperation with the librarians of the Department of Agriculture and of the Bureau of Entomology.

DISEASES OF BEES

During the year 780 samples of brood and adult bees were submitted for diagnoses. The number of samples of treated comb, which necessitate cultural tests to determine sterility, has increased considerably over similar work in previous years. Seventy-six queen bees were imported from foreign countries for various scientific institutions and queen breeders.

The majority of samples submitted by honey producers who have tried the gas method for disinfecting American foul-brood combs showed lack of sterility. The reasons for failure of this method when employed outside the laboratory seem to be that the tanks and fumigating rooms used by beekeepers have not contained sufficient formaldehyde and that the period of exposure has been too short. The gas method for sterilizing brood combs infected with *Bacillus larvae* is not promising.

A report of laboratory studies dealing with the fumigation of American foul-brood combs in glass jars, paraffined hive bodies, and large tanks is being prepared for publication.

In connection with the work of fumigation, it has been the practice hitherto to allow treated combs to dry thoroughly before culturing them, in order to remove as much of the formaldehyde as possible; but it has been discovered that even though the odor of formaldehyde may not be detected in treated scales they often retain sufficient formaldehyde to inhibit or entirely prevent the growth of the organism in culture. This being the case, all treated scales are now thoroughly washed before culturing. The time during which

cultures are kept under observation in the incubator has also been lengthened, as it is found that the incubation period varies much more than was hitherto supposed. This is particularly true of the organism when it is obtained from treated combs. A report covering this work was published in one of the domestic bee journals.

INTERMOUNTAIN LABORATORY

The work of the intermountain field laboratory is being done under a cooperative agreement with the University of Wyoming. Efforts to determine the minimum number of spores per cubic centimeter necessary to cause American foul brood in a colony have been continued at Laramie, Wyo. It was found that an error had been made in calculating the number of spores used in previous experiments, and that the figures obtained were only one one-hundredth as large as they should be. A modification of the method devised by Breed for counting bacteria in milk was used to count the spores in a suspension of sugar sirup. By this method the results checked with those previously obtained by means of the Helber bacteria-counting cell. It was found that a minimum number of 50,000 spores per cubic centimeter, or a total of 50,000,000 spores per liter of sugar sirup, fed to a healthy colony would produce disease, whereas to date a smaller number has failed to produce disease. In conjunction with these experiments, individual larvae are being fed a definite number of spores to determine the actual minimum lethal dose.

In the study of the spread of American foul brood in commercial apiaries, the method for detecting a weak vegetative growth of *Bacillus larvae* has been improved. A medium which is a combination of the yeast egg-yolk suspension and Lochhead's carrot-extract medium gave a delicate test for slight quantities of *B. larvae*. A very characteristic positive nitrate-reduction reaction resulted from using the naphthylamine and sulphuric acid test. This method was used also in detecting spores of *B. larvae* removed from commercial honeys. As a check on the number of spores found in commercial honeys, field feeding tests will be conducted with part of the identical sample used in making laboratory cultures.

In attempting to determine the effect of commercial honeys in the spread of American foul brood it was found that less than a certain minimum number of spores per cubic centimeter growth in culture could not be obtained even after 30 days' incubation.

The third year of studies dealing with the flight range of the honeybee was concluded in the fall of 1929. During the course of the experiment it was found that when necessity demanded, bees flew at least 8½ miles to a source of nectar and returned. A distance of 2 miles from the source of nectar had but little effect on the average gain in weight made by colonies. Beyond a 2-mile point the gain decreased with the increase in distance. During 1928, which was a good honey year, all colonies located on a line extending for 7 miles into the Bad Lands made slight gains in weight, those beyond losing weight, whereas in 1929 colonies located 5 miles and more from the source of nectar lost in weight. In 1929 a loss in weight was recorded for colonies located 6 miles and more from the source of nectar. During the three years, colonies located some distance from the source of nectar made greater gains than colonies

located within the source of nectar. During the summer of 1930 studies are being conducted near Alamosa, Colo., in the San Luis Valley, in an effort to determine the distribution of bees within the source of nectar. A paper entitled "The Flight Range of the Honey-bee," giving the results of the three seasons' work, has been prepared.

Various methods of wintering in the Intermountain States are being studied in which experimental colonies and colonies belonging to commercial honey producers at Fromberg, Mont., Fort Collins, Colo., and Lander and Laramie, Wyo., are being used. Different methods of packing, the contrasts between cellar and outdoor wintering, the use of upward ventilation, and other factors are being given attention. Colonies of Italian and Caucasian bees are being used.

SOUTHERN STATES LABORATORY

A study of the various types and sizes of packages used by the producers of package bees has reached the point where it seems quite possible that three or four standard cages can be recommended to take care of all the needs of the package-bee shipping industry. Two of these packages are designed for the shipment of nuclei or frame packages, and the other two for the 2-pound or 3-pound combless package. After the shippers have had an opportunity to study the types of cages which appear best, both from the standpoint of successful shipping and from that of economical construction, efforts will be made to give all shippers of package bees an opportunity to adopt these cages. Not only are the sizes and types of cages being studied, but the position of the queen bee in the package, the kind and quantity of food, the method of crating, the amount of ventilation, and other factors are being given careful consideration. Trial shipments of package bees in containers of different styles have been made, to learn the effect of actual travel conditions upon package bees.

In conjunction with the study of the plants producing nectar and pollen in the Southern States, begun last year, particular attention is being given to the blooming period of plants, their abundance and distribution, and their periods of nectar secretion. An attempt is also being made to determine whether the variation in hydrogen-ion concentration of the soils is correlated with the secretion of nectar from certain plants. Over 200 specimens of southern plants upon which honeybees have been observed gathering pollen or nectar, or both, have been collected by the Southern States Bee Culture Field Laboratory. Both the department of botany of the University of Louisiana and the Bureau of Plant Industry have given assistance in the identification of these plants. Colonies of bees have been located within range of areas of *Trifolium repens*, *Senecio glabellus*, and *Sabal* sp. (palmetto) to determine the quantity of nectar secreted and the effect of weather factors upon these plants during the period of nectar secretion. Colonies of bees have also been placed within a large wooded swampy area to determine the value of miscellaneous plants growing within the swamps.

A study is being made of the number of egg tubules comprising the ovaries of queen bees, and the relation between the number of egg tubules and the egg-laying capacity of queens. Queen bees already examined from various southern breeders show that the number of

egg tubules ranges from 90 to 175. Queens will be reared under different experimental conditions to determine the influence of certain environmental factors upon the number of egg tubules. In close relation to this, bees from various southern breeders are being collected to determine the extent of variation in strains sold by different breeders, and to determine if possible what headway toward the improvement of stock has been made by breeders who are making a conscientious effort to improve their bees.

Work on hand-mating of queen bees without the use of instruments has been conducted during the past season, and the results obtained so far indicate that the method has considerable promise, for a partial degree of insemination can be effected in all cases. The Southern States laboratory possesses a few hand-mated queens that to all appearances are equal to those mated in nature. For the time being efforts will be concentrated upon the technic of insemination. For this reason many queens are dissected shortly after being inseminated and the results checked with the spermatheca of naturally mated queens.

TAXONOMY AND INTERRELATIONS OF INSECTS

As at present organized, this division includes several different units, all representing fundamental studies of insects and insect relations. The taxonomic unit covers technical or basic work with insects, including their scientific study from the standpoint of identification and classification, conducted in cooperation with the United States National Museum. In addition to such strictly taxonomic work, this division includes the insect-pest survey work of the bureau, which has been maintained for several years, and also studies in insect anatomy, morphology, and physiology, and a special investigation which has been going on for some years under the title of research in bioclimatics, dealing with insect occurrence and biology as influenced by climatic conditions. The determinations which are made by the bureau in the field of insect diseases also are brought under this division, which as a whole has been under the personal supervision of the chief of bureau.

TAXONOMIC UNIT

The investigations in taxonomy have been conducted under the direction of Harold Morrison. The summary of determinations made, as given later, indicates that there has been an increase in the demand for service from this unit and that this increase has been met with some success.

While definite progress in the way of organizing the collections for proper study and identification purposes was made in all groups during the year, there was the greatest development in the Coleoptera in this respect since the addition of a specialist to work particularly on the weevils permitted the dividing up of the work on the Coleoptera and the assigning of important families and groups to individual specialists. A great deal of work of this sort is still to be done before the collections attain a condition which will permit their really effective utilization for identification work.

The needs of the bureau for additional specialists in insect classification remain serious. The most important needs at the present

time, as indicated in the requests for increases covering work in various groups, are for specialists and accessory assistants for studies on cutworms, for studies on scale insects, for studies on May beetles and click beetles, for studies on sawflies and parasitic wasps, and for studies on parasitic flies. Increases have been granted by Congress which will permit the employment of a specialist to work on the true bugs and a specialist to work on mosquitoes and other blood-sucking flies. Steps are now being taken to employ these specialists.

A check of our records indicates that 13,750 identifications have been made during the fiscal year. The service so supplied has benefited many branches of the Department of Agriculture, the National Museum, the Smithsonian Institution, the Public Health Service, and other Government departments or branches, State experiment station workers, college and university workers, and many individuals in the United States and elsewhere interested in entomology. The tabulation of the identifications made, by insect orders, follows:

Order	Identifications	Order	Identifications
Coleoptera -----	3, 594	Ectoparasites and mites -----	524
Lepidoptera -----	2, 983	Hemiptera -----	436
Diptera -----	2, 034	Coccidae -----	1, 490
Hymenoptera -----	2, 127		
Orthoptera and Neuroptera ---	562	Total -----	13, 750

This total is the largest that has been reported for identification work by the taxonomic group since the beginning of record keeping, and it appears, so far as the trends represented have been studied, to represent not only an absolute increase but also an increase in average difficulty of the work, since the reduction—remarked on in last year's report—in requests from the Plant Quarantine and Control Administration for the identification of relatively common, well-known species is again apparent in the work performed during the fiscal year 1930.

The outstanding development in the year's taxonomic work undoubtedly is to be found in the purchase of the Barnes collection of Lepidoptera at a cost of \$50,000. This item was carried in the second deficiency bill and was approved by Congress just after the close of the fiscal year. As a result of this purchase more than 450,000 specimens, including many types and a practically complete representation of the species of Lepidoptera of the United States, will be added to the collections available to specialists for study purposes. Also, the purchase enables the department to acquire an extensive special library on the classification of Lepidoptera, including many rare technical papers and a card catalogue said to contain reference cards giving citations for every time a United States species of Lepidoptera has been mentioned in scientific literature.

The progress made in the preparation of monographic and other critical studies in the various projects has been, briefly, as follows:

COLEOPTERA

The arrangement whereby F. Ohaus, of Mainz, Germany, has identified large numbers of beetles belonging to the scarabaeid subfamily Rutelinae for the benefit of the bureau has been continued. As a result of the work of Doctor Ohaus and the bureau specialist on this group the collection in this subfamily, which includes the

Japanese beetle and many other pests of great economic importance, is in such condition that it can be used most efficiently for identification work. As it stands to-day it is probably the second or third best collection of these insects in the world.

In July, 1929, a specialist was added to the staff to care for certain groups, particularly the weevils, but owing to the fact that he remains on a half-time basis for the present, in order to complete certain work which he had undertaken for the Smithsonian Institution, there has been but little opportunity for him to undertake serious investigational work. Several papers describing new species of Cerambycidae and Buprestidae from various parts of the world have been completed and offered for publication. Work on coleopterous larvae has been very actively continued, two papers having been published and several others advanced, including an extended paper on the classification of the larvae of the whole order.

LEPIDOPTERA

Work has been continued on the Tortricidae, and comparative studies undertaken on some secondary sexual characters of certain families of microlepidoptera. Study on the American Phycitinae has been further advanced, but in all probability it will be several years before the monographic work on it has been completed. In addition, to meet certain problems which developed during the year, special studies on certain genera of Noctuidae have been undertaken.

The work of adding the Brooklyn Museum collection of Lepidoptera, transferred from that institution to the United States National Museum last year, has been completed, and in this connection many thousands of specimens have been properly classified and arranged. In addition to this, work has been conducted on Geometridae and neotropical species of certain other families and subfamilies. Preparation of a report on Lepidoptera in connection with the Biological Survey of Porto Rico, which was organized under the auspices of the American Museum of Natural History, has been in progress for some time.

DIPTERA

The bureau's specialist on fly larvae has continued to serve in making identifications of mosquitoes and other blood-sucking flies, a task in addition to his regular duties which he has carried for more than a year and a half. In the course of his work he has been able to give identifications or other assistance to a considerable number of entomologists, but the extra duties which he has assumed have prevented the completion of investigational work which he has had in progress.

HYMENOPTERA

In addition to the regular identification work, study on the genus *Trichogramma* has been continued. The study of this genus has developed certain complexities which have retarded completion of a paper. Several papers dealing with various groups of species of Ichneumonidae have been completed and published during the year. Preliminary studies on the classification of different genera of bees and wasps have been made in order to facilitate determination work on them.

ORTHOPTERA AND NEUROPTERA

By request, the bureau's specialist on these orders has during this fiscal year undertaken a study of the Copeognatha (book lice, etc.) of the world in order that he may supply to the Plant Quarantine and Control Administration identifications for the material which they collect rather frequently in the course of their port-inspection work. He is successfully familiarizing himself with the classification of this order of insects and with the species included in it so that he is now supplying desired information on these insects to the Plant Quarantine and Control Administration and others.

ECTOPARASITES AND MITES

Papers describing new species of Mallophaga and mites have been prepared during the year and revisional studies on the feather mites continued. Field studies on the biology of the chiggers have also been continued.

COCCIDAE

The situation in the Coccidae remains much as it was in the previous fiscal year. Developmental work which will permit the production of monographic or other research papers has been kept up, so that when there is an opportunity it should be possible to prepare and publish some very useful papers on the classification of scale insects. There is no possibility of this under present conditions, since general administrative work takes up a large part of the time of the specialist on Coccidae, and in consequence many demands for identifications and other assistance either have not been met at all or have been met unsatisfactorily.

The outstanding development in connection with the bureau's coccid work for the past year undoubtedly is the acquisition by purchase of the C. F. Brain collection of South African Coccidae, including types or authentically identified examples of almost all of the species which Doctor Brain described in the course of his work in South Africa on this family. This most important and useful addition to the collection will permit the accurate identification of specimens from South Africa now received through the Plant Quarantine and Control Administration and other sources.

It is anticipated that the further increase in staff which will be made during the coming year will result in improved effectiveness in the handling of identification and other service work of the taxonomic unit and greater benefit to all those needing assistance, but there must be a marked further increase in the staff and additional reorganization of the work before it will be possible to perform the duties assigned to the unit in a wholly satisfactory fashion.

INSECT-PEST SURVEY

The insect-pest survey, as in the past, has been under the direction of J. A. Hyslop.

The purpose of the insect-pest survey is to maintain and make available a permanent record of insect abundance and damage and to make such studies and research of those records as may lead to determination of the basic factors of insect distribution and abun-

dance. This survey is carried out in cooperation with all of the States having organized entomological activities and by informal arrangements includes also Canada, Cuba, Porto Rico, Haiti, Mexico, and the Hawaiian Islands. The total number of regular reporters on insect conditions is now 87.

A monthly record of the insect conditions as reported to the survey is issued, some nine volumes of which have now been completed. These records are distributed to several offices of the Bureau of Entomology, to the field stations of the bureau and also of the Plant Quarantine and Control Administration, and to State institutions and all collaborating agencies, domestic and foreign.

An index is being maintained of all the records of both North American and foreign insect pests, and this catalogue is being cross indexed under host-plant names. Maps are also being prepared showing the distribution of important insects both as to foreign countries and within the United States.

As heretofore the insect-pest survey has acted as clearing house for material furnished the Radio Service on entomological subjects and has supervised the construction of exhibit material to be used by the office of exhibits in the State fairs. The survey has also brought together the plans for the Bureau of Entomology's exhibit at the Chicago Century of Progress World's Fair, and the exhibit displayed in connection with the Inter-American Conference held at the Pan American Union this fall.

MISCELLANEOUS SUBJECTS

The technical studies on insect anatomy, morphology, and physiology are being conducted by R. E. Snodgrass. A considerable number of important papers representing this specialized work have already been published, largely through the channel of technical reports of the Smithsonian Institution. Four additional papers have been completed and will shortly be published. These are: (1) How Insects Fly—a nontechnical account of the mechanism of insect wings, their movement during flight, and a summary of what is known concerning the mechanics of insect flight; (2) The Morphology of the Insect Abdomen—a general review of the structure of the abdomen of insects, including a study of the skeleton and the musculature, with the particular object of obtaining new information to help solve some of the problems involved in the study of the organs of oviposition and copulation; (3) The Abdominal Mechanisms of a Grasshopper—a complete study of the abdominal skeleton and musculature of *Dissosteira carolina* L. giving particular attention to the mechanisms of respiration, circulation, oviposition, and copulation; (4) How Insects Feed—a nontechnical account of the various types of feeding mechanisms of insects, designed for the annual report of the Smithsonian Institution. In addition to these, a very important paper dealing with the morphology and physiology of the alimentary canal of insects is in progress. This paper is to include the morphology, histology, and metamorphosis of the digestive tract in the principal groups of insects, together with a review of all that is known of the digestive processes in insects, the enzymes that have been found in the alimentary canal, and an abstract of the various published opinions on insect digestion and absorption.

The research in bioclimatics (biologic and climatic relations) has been in progress for a number of years under the direction of A. D. Hopkins. This work has now advanced to the stage of making possible an early publication. It represents a study, along entirely original lines, of bioclimatic principles as related to special problems in entomology, ecology, climatology, meteorology, and geographical distribution of plants and animals, but having special relation to insects. It is believed that the utility of this study will be its applicability not only to all types of life but particularly to the determining of the probable geographic range of introduced species within which spread and survival can be predicted. It should also be a useful guide to the determination, for different regions or areas within the United States broadly, and also as to limited or local areas, of the appropriate time for local-control operations, as, for example, the date of planting wheat to protect it from attack by the Hessian fly. A large field of usefulness in this and many other directions is anticipated by Doctor Hopkins.

The study of insect diseases, particularly for the purpose of their utilization in the control of insect pests, was included in the original plan of reorganization when the old Division of Entomology was raised to the bureau status. While the importance of such work and its possibilities have been fully recognized, funds for personnel have not been available to develop this field in any large way. Some early and very important work was completed and published in the study of diseases of the domestic honeybee. In general in this field the bureau's work, however, has been largely the examination and identification of various types of disease which are sent in for study and report. G. F. White is the bureau's specialist in this field.

REPORT OF THE ACTING CHIEF OF THE OFFICE OF EXPERIMENT STATIONS

UNITED STATES DEPARTMENT OF AGRICULTURE,
OFFICE OF EXPERIMENT STATIONS.
Washington, D. C., August 30, 1930.

SIR: I transmit herewith a report of the Office of Experiment Stations for the fiscal year ended June 30, 1930.

Respectfully,

WALTER H. EVANS, *Acting Chief.*

Hon. ARTHUR M. HYDE,

Secretary of Agriculture.

The Office of Experiment Stations administered as heretofore the Federal acts making appropriations for the State agricultural experiment stations and for the experiment stations maintained by the department in Alaska, Hawaii, Porto Rico, Guam, and the Virgin Islands. This involved supervision of the use of Federal funds amounting to \$4,335,000 (\$90,000 to each State and \$15,000 to Hawaii) provided by the Hatch, Adams, and Purnell Acts and \$247,000 appropriated for the Alaska and insular stations. The office also maintained close advisory relations with station work supported by State and other funds which make the present annual income of the stations about \$17,000,000.

The Purnell Act reached its maximum of \$60,000 annually for each State during the year. This act authorized an initial appropriation of \$20,000 for each State for the fiscal year 1926, with annual increments of \$10,000 until a total of \$60,000 had been reached, which amount was then to become the fixed annual appropriation under the act.

ADMINISTRATION OF THE FEDERAL ACTS

The administration of the Federal acts making appropriations for the experiment stations requires consideration before approval of all projects supported by the Adams and Purnell funds, the keeping of records of all approved projects with reference to plan of work, method of procedure, and allotment of funds, and examination of the work and expenditures of the stations to ascertain whether they are in accord with the purposes of the acts. More than 1,600 Adams and Purnell projects were examined in detail during the year. The progress in nearly 5,500 projects supported by Hatch, State, and other funds was noted, and pay rolls and other expenditures were examined with a view to making such adjustments as might be deemed necessary. It is worthy of note that adjustments in expendi-

tures were necessary in only a few instances, and most of these were of minor importance.

A representative of the office visited each of the stations during the year for the purpose of making a personal examination of its work and expenditures. Six members of the office staff—E. W. Allen, Walter H. Evans, W. H. Beal, J. I. Schulte, R. W. Trullinger, and B. Youngblood—took part in this work, which involved not only examination of accounts but consultation with the director of the station and leaders of the various projects; discussion of matters of administration, policy, and personnel; inquiry into facilities for research, and consideration of programs of work; and the preparation of a report on each station. These activities, embracing a complete inspection of the stations in the 48 States, require annually from 265 to 275 days and from 35,000 to 37,000 miles of travel.

STATION PROJECTS

Examination of research projects submitted to the office for approval occupies a considerable part of the time of the technical staff. During the past year over 300 new projects were submitted for approval and about 100 old projects were considered with reference to modification or revision. This work calls for critical judgment and constructive advice and suggestion regarding the planning and execution of research.

A revised classified list of station projects was submitted for publication during the year. This list includes over 7,000 projects. Its preparation was a large undertaking in which nearly all members of the technical staff of the office participated. It shows the number of projects in the different subjects to be as follows: Agricultural chemistry, 58; agricultural economics, 463; agricultural engineering, 312; animal husbandry, 1,015; dairying, 145; economic entomology, 525; economic zoology, 45; field crops, 1,864; food technology, 17; forestry, 138; genetics, 189; home economics, 158; horticulture, 1,224; meteorology, 8; plant pathology, 575; plant physiology, 87; rural sociology, 46; soils and fertilizers, 519; and veterinary medicine, 284.

Decided progress was made during the year in strengthening the research projects and programs of the stations and in developing their cooperative relationships. The projects are constantly becoming more technical and the research is extending into the newer fields of agricultural economics, rural sociology, home economics, and agricultural engineering, which call especially for cooperative effort on a large scale.

CONFERENCES AND CONTACTS

Representatives of the office took part in meetings relating to the work of the experiment stations, presented papers, and served on committees. These included the conventions of the Association of Land-Grant Colleges and Universities, Association of Southern Agricultural Workers, American Association for the Advancement of Science, American Society of Agronomy, American Soil Survey Association, American Society of Agricultural Engineers, American Society of Animal Production, Association of Official Agricultural Chemists, American Home Economics Association, and Federated

Biological Societies. R. W. Trullinger, of the office staff, was elected president of the American Society of Agricultural Engineers. The office also was represented in various special conferences and committees dealing with research in economics, agricultural engineering, agronomy, horticulture, animal husbandry, and home economics.

Members of the staff held numerous conferences in the office with specialists from the stations, other divisions of the department, and commercial organizations in regard to various problems of agricultural research, and with foreign scientists contemplating visits to the experiment stations.

COOPERATION

The office continued to review the proposals by the several bureaus of the department for cooperative research with the State experiment stations, submitted for the approval of the Director of Scientific Work, and also maintained a record of cooperative undertakings.

On June 30, 1930, there were 1,169 active research projects of the State experiment stations, which were cooperative between the stations or with the different bureaus of the Department of Agriculture. There was a net increase of about 10 per cent in cooperative projects during the year. Nearly 100 of such projects were indicated as completed or closed during the year, and approximately 200 new cooperative undertakings were examined and reported on.

The cooperative projects active at the end of the fiscal year comprised 398 in plant improvement, plant genetics, field crops, pastures and ranges, horticulture, pomology, and plant diseases, largely with the Bureau of Plant Industry; 304 projects in agricultural economics and rural sociology, mainly with the Bureau of Agricultural Economics; and 134 projects in animal production, animal pathology, and animal genetics, mainly with the Bureau of Animal Industry. There were 88 projects concerned with soils, soil surveys, soil fertility, fertilizers and chemistry, mainly with the Bureau of Chemistry and Soils; 86 projects in entomology and zoology, mainly with the Bureau of Entomology; 68 projects in agricultural engineering, mainly with the Bureau of Public Roads; 50 projects in dairy industry, mainly with the Bureau of Dairy Industry; and 25 projects in forestry, mainly with the Forest Service. Other cooperative projects include 10 in human foods and home management, mainly with the Bureau of Home Economics; and 6 projects in meteorology, mainly with the Weather Bureau. Of the total number of active cooperative projects, 169, or about 14 per cent, receive support from Purnell funds and 17, or about 2 per cent, from Adams funds.

All of the State experiment stations were involved in the cooperative enterprises, California, Washington, North Carolina, Montana, Wisconsin, Virginia, and Oregon leading with 53, 49, 48, 41, 40, 36, and 36 cooperative projects, respectively. There were also in operation about 21 major regional projects which involved the cooperation of from 3 to more than 30 stations and included from 1 to 3 bureaus of the department.

During the year there was established a more uniform method of arranging for cooperation between the bureaus and the stations and of securing a more complete record of cooperative projects. Close relations were continued with the joint committee of the Association

of Land-Grant Colleges and Universities and the department on projects and correlation of research.

INSULAR STATIONS

The work at the experiment stations maintained by the department in Alaska, Hawaii, Porto Rico, Guam, and the Virgin Islands, under the administrative direction of Walter H. Evans, continued to center upon the general line of diversified agriculture. Much pioneer work is necessary at every station to learn what are the most urgent problems and the methods to be adopted for their solution. As rapidly as possible the stations are devoting more attention to studies of the principles underlying agricultural practices that are of local application, the results of which may also apply to other regions similarly situated.

The total incomes of the stations for the fiscal year ended June 30, 1930, were: Alaska, \$85,000; Hawaii, \$45,000; Porto Rico, \$59,000; Guam, \$29,000; and the Virgin Islands station, \$29,000. The proceeds from the sale of products during the same period amounted to \$4,295.72. These funds were deposited in the Treasury as miscellaneous receipts and were not available for station maintenance. Each of the stations is in need of larger appropriations to make possible the carrying on of its work in a more efficient manner. Personnel and equipment are lacking for important investigations in fields that are now neglected or very inadequately served.

ALASKA STATIONS

The work of the Alaska stations was reorganized to some extent, and the investigations are being centered at the Matanuska station. The placing of all livestock work under the animal husbandman of the Matanuska station worked out so well that preliminary arrangements were made to concentrate the research features of agronomy investigations in a similar manner. The agronomist of the Fairbanks station visited the Matanuska station during the year and reviewed the experiments in progress. As a result of his study much of the plant-breeding and plat work with cereals and forage plants is now carried on at the Matanuska station. The erection of a house for the horticulturist and a propagating house and laboratory made it possible to develop horticultural work at the Matanuska station, and plantings of orchard and small fruits were made to determine their adaptability to the region.

Animal-husbandry work is carried on at the Fairbanks, Matanuska, and Kodiak stations. At Fairbanks the experimental work consists mainly of an effort to produce a hardy type of beef animal for the interior of Alaska by crossing the Asiatic yak with Galloway cattle. The hybrids have proved to be very hardy and they require little shelter or feeding during the winter season. Through the courtesy of the Canadian Government the station was able to add a young bull and three heifer yaks to this breeding experiment during the past year, and it is expected that the work will now proceed more rapidly. The work on Kodiak Island is mainly range-management studies with cattle to determine their winter requirements of feed and shelter. At the Matanuska station the livestock work in-

cludes feeding and management studies with dairy cattle, swine, sheep, and poultry. The experiment in the production of a hardy milk cow by crossing the Holstein and Galloway breeds is progressing very satisfactorily. The best crossbred cow last year produced in the first 100 days of her lactation period 5,552.5 pounds of milk as compared with 4,993.9 pounds for the best Holstein in the herd. Both cows freshened at about the same time and received the same care and feeding. One crossbred heifer produced, during her first lactation period, 10,109.8 pounds of milk with an average butterfat content of 5 per cent.

The work at the Sitka station was reduced considerably and is now limited to tests of small fruits, vegetables, and ornamentals for southeastern Alaska home gardens.

The stations are cooperating with the Alaska Railroad in the operation of a dairy at Curry and in land-clearing experiments in the vicinity of the Matanuska station. The dairy is financed by the railroad and managed under the supervision of the animal husbandman of the station. The railroad buys cream at any station along its route. Cooperative livestock breeding and dairy work is in progress at the Eklutna Industrial School, which is under the Office of Education, Department of the Interior.

HAWAII STATION

The joint control by the United States Department of Agriculture and the University of Hawaii of the Hawaii Agricultural Experiment Station has proved very satisfactory in its first year. After the extension to Hawaii of the Hatch and supplementary acts on May 16, 1928, a cooperative agreement was entered into between the Department of Agriculture and the University of Hawaii whereby the experiment stations maintained by each were combined into a single institution under the joint control of the cooperating agencies. There is now a single experiment station, with the former director of the Federal station in charge. The property of each institution is kept separate, but there has been considerable pooling of interests, personnel, and facilities, with a corresponding increase in efficiency and economy of administration. The enlarged station had for its support the direct appropriation made by Congress, the Hatch fund, and Territorial and other funds.

Under the cooperative agreement the horticulture, chemistry, and soils projects in progress at the Federal station for several years were continued, and the agronomy work was increased considerably by the inclusion of a number of projects that had been supported by the university. The substation at Makawao, Maui, was retained to test, at a considerably higher elevation, the results of agronomic investigations carried on at Honolulu. Some very striking differences in varietal response have been obtained for a number of crop plants.

The animal-husbandry work begun by the university was continued and enlarged. Projects on feeding molasses to dairy cows and the effect of feeding sprouted oats to breeding cows and brood sows were extended. Studies of a number of poultry problems that are of large local importance were started. In soil physics work was begun on the study of factors which affect the rate and magnitude of the capillary rise of water and its movement through colloidal soils. In

a newly established nutrition laboratory experiments were begun on the vitamin content of Hawaiian-grown oranges and tomatoes in comparison with those received from the mainland. Other work includes an investigation on the nutritive value of Chinese cabbage and of the protein in the pigeon pea.

The chemist, in addition to the canna-starch work in progress for some years, undertook a study of the coffee soils of the Kona district on the island of Hawaii and of means for the rejuvenation of old coffee plantations. One assistant is studying soil colloids and another is attempting to develop means for the commercial utilization of surplus fruits, which can not be exported because of prohibitive quarantine regulations.

The coordinated station has secured more cooperation in its work than formerly, and the combined fields of activity are considerably greater than ever before.

PORTO RICO STATION

The retirement on April 22 of D. W. May, who was for nearly 26 years director of this station, was one of the important events of the past year. Under his supervision the research staff was enlarged from three workers in 1904 to eight in 1930, and the income of the station was increased nearly fourfold. In addition to his administrative duties, Mr. May was actively associated with the station's work in livestock improvement and management, sanitary dairying, tick eradication, forage-plant introduction, and the reforestation of denuded lands.

Mr. May was succeeded as director of the station by George F. Freeman, who was formerly connected with the Kansas, Arizona, and Texas experiment stations, and at the time of his appointment was director general of the Service Technique, Haiti, a position which included instruction and research in agriculture. Before going to Haiti Doctor Freeman was engaged for several years in cotton-breeding work for the Egyptian Government and in a survey of Indo-China as a prospective cotton-producing country.

C. M. Tucker, for nearly seven years plant pathologist of the station, resigned April 15 to accept a position with the Florida Agricultural Experiment Station.

The work in dairying and animal breeding, supervised by the former director, was taken over temporarily by H. L. Van Volkenberg, the parasitologist of the station.

The position of associate entomologist at the Porto Rico station continues to be unfilled, and the position of research chemist also is vacant. The station is well equipped with laboratory facilities and it is hoped that these vacancies can be filled in the near future, for there are numerous problems that need to be studied.

Cooperative work with the department in several lines has been arranged, and the facilities of the station are extended to others who desire opportunity for tropical research.

The station staff is concentrating its research on 21 projects, those in entomology and plant pathology being suspended temporarily. Satisfactory progress is reported on all of the active projects.

As a further aid to the rehabilitation of coffee plantations, which were damaged seriously by the hurricane of September, 1928, the

station supplied planters with seed enough to replant nearly 2,000 acres from its plantings of Excelsa and other varieties of coffee that withstood the storm. The Excelsa variety, a station introduction, is being planted extensively to replace the variety commonly grown.

Plant-breeding work, especially that with sugarcane, is developing rapidly. Several station seedling varieties that are resistant or immune to mosaic and have good agronomic characters and high sucrose content are being tested cooperatively on 21 plantations in comparison with standard varieties.

Largely as a result of the station's work with citrus fruits and pineapples, a commercial precooling plant was erected at San Juan and the fruit is reported as now reaching New York in much better condition than formerly.

GUAM STATION

A small increase in the appropriation for the Guam station made it possible to resume, in part, the extension work in agriculture terminated in 1921 on account of a reduction in the station's income. Antonio I. Cruz, a native of Guam, who received part of his education in the States and graduated from the University of Hawaii, was, in September, 1929, placed in charge of the station activities in agricultural extension. The reorganized work consists of boys' and girls' clubs and adult demonstrations, the club work being carried on in cooperation with the local department of public instruction. The clubs organized embrace eight activities—rice, corn, copra, horticulture, root crops, home gardens, pigs, and poultry—and at the end of the fiscal year had a total enrollment of 863. This work is supervised closely, and its restoration as a station activity has been received very favorably by the people of the island. The demonstration work with adults consists of cooperative projects with farmers, so planned as to make practical use of the results of the station's investigations. The reestablishment of the extension work has enabled the station to maintain closer contacts with the farmers of the island than was possible without it. This was very clearly evident in the increased number of requests received during the year for information and planting material.

The efforts to improve the livestock of the station by the use of purebred sires continued to give excellent results, and the station now possesses a creditable herd of grade Ayrshire cattle, purebred and grade Duroc-Jersey pigs, and purebred and grade White Leghorn chickens. During the year considerable surplus stock was sold to ranchers for breeding purposes. Rearing livestock in Guam is attended with many difficulties, among them being heavy infestation of parasites. The station has turned its attention to parasite control with very promising results, especially with poultry. A disease of cattle and carabao pastured on the savannas was found to be a deficiency disorder that was readily controlled by feeding bone meal.

In feeding experiments copra meal continued to give satisfactory results when fed as a part of the ration for all kinds of stock. This is very fortunate, since an ample supply of copra meal can be obtained at a reasonable price. For young pigs copra meal was found superior to fresh coconut, the common ration for growing pigs.

Forage plant adaptability tests constitute an important feature of the work of the station. Of the grasses tested, Napier and Guatemala grasses appear to be most widely adapted for growing for stock feed. Various leguminous plants are being tested for forage and soil improvement and for weed control.

The station's experiments with pineapples have resulted in a commercial planting for canning. Yellows, due to a lack of iron, was found to yield to spraying with a solution of iron sulphate, a method originated by the Hawaii station.

The work of the entomologist in introducing, breeding, and distributing insect parasites was continued, with promising results. Following the introduction and breeding of parasites, it was found that from 75 to 80 per cent of the house-fly pupæ about the station premises were parasitized, thus greatly reducing the numbers of these pests.

VIRGIN ISLANDS STATION

The restoration of the water supply of the station, which had been damaged badly in the hurricane of September, 1928, was completed during the year. Galvanized-iron roofing and concrete paving to form catchment areas were reconstructed and an additional cistern of 30,000 gallons capacity was added to the water-storage system of the station. In the Virgin Islands so much dependence is placed on stored water that efforts are made to increase the supplies whenever possible.

The appointment, during the latter part of the fiscal year, of a veterinarian, who serves also as animal husbandman, greatly increased the activities of the station. In cooperation with local authorities, the veterinarian was placed in charge of the quarantine work of the islands. Inspections were made of 536 animals imported into the islands during the year, and certificates were issued for the export shipment of 1,225 cattle. Interest in the control of cattle ticks was aroused, and 5,326 head of cattle were passed through the station vat during the year. A number of private dipping vats were installed at various places, the veterinarian testing the dipping solutions from time to time to insure their safety and efficiency.

The field and horticultural work of the station proceeded about as formerly. Seedling sweetpotato No. 794, which was tested extensively during the year, yielded almost 70 per cent more sweetpotatoes of better quality than the variety usually planted. From sugarcane-breeding experiments several new varieties have been obtained which give promise of increased yields over S. C. 124, a station product that is now the dominant variety of sugarcane in St. Croix. A series of forage plants were planted in an effort to secure varieties that are adapted to local conditions, and especially to test their ability to withstand drought.

The horticultural work was mainly with vegetables and fruits, and some very promising varieties were obtained that are being tested under varying conditions. Experiments were begun with forest trees for restocking the denuded areas which occur all over the islands, and some significant data on the adaptability of certain species were secured.

The extension and demonstration work on St. Thomas and St. John continued to progress. The extension agent acted also as live-stock quarantine officer of these islands.

At the request of the Governor of the Virgin Islands and the Committees on Appropriations and Insular Affairs of the House of Representatives, United States Congress, the Bureau of Efficiency made a survey of economic conditions in the Virgin Islands during the year. A report on the situation with recommendations was submitted to the Appropriations Committee. Among other matters considered of immediate need the report recommended a considerable increase in the personnel and equipment of the station to enable it to expand its work along a number of lines. An appropriation was made by Congress to be expended under the direction of the President, but the amount was less than that recommended by the Bureau of Efficiency, and the items for which the funds were to be expended were not specified. A resurvey of the situation was therefore necessary, and the sum to be expended for the station has not yet been determined.

PUBLICATIONS

The publications of the office deal primarily with the organization, administration, and progress of agricultural research and with reports of the work of the agricultural experiment stations in Alaska, Hawaii, and the insular possessions. The usual publications giving information regarding income and expenditures, personnel, facilities for research, and publications of the stations, and the progress of agricultural research in this and other countries were continued as heretofore.

The progress of agricultural research in general was reviewed in the Experiment Station Record, of which the usual numbers and an index were issued. The work of the experiment stations, with discussion of questions of organization and policy, was reviewed in a Report on the Agricultural Experiment Stations, 1928. A similar report for 1929 was prepared and submitted for publication. Lists of workers in the State agricultural colleges and experiment stations and of bulletins of the experiment stations were published, as was a revision of a circular on Federal Legislation, Regulations, and Rulings Affecting Land-Grant Colleges and Experiment Stations. A revised list of the research projects of the stations was prepared and submitted for publication. Seven annual reports and four bulletins of the insular stations were published. An article reporting work at the Porto Rico station on the Pokkah Boeng Disease and Chlorotic Blotch of Sugarcane in Porto Rico, by C. M. Tucker, was prepared for publication in the Journal of Agricultural Research, and members of the office staff published a number of articles, relating to research in agricultural economics, engineering, home economics, and animal genetics, in outside periodicals. In all, 36 documents, aggregating 2,989 pages, were published during the year in regular department series.

EXPERIMENT STATION RECORD

The editorial management of the Experiment Station Record continued in charge of H. L. Knight, with no changes in staff personnel

but with some temporary reassignments of duties. Volumes 61 and 62 of the Record were brought to completion. These volumes comprised a total of 18 numbers, each of 100 pages, and devoted as usual primarily to abstracts of the world's current literature pertaining to agricultural science. About 7 per cent of the total space was utilized for monthly editorial discussions of significant developments in agricultural education and research and brief notes in each issue on current progress along these lines. In addition, the customary index number of about 100 pages was prepared for each volume.

The editorial policy of the Record was maintained without substantial change. Among the matters discussed editorially in the Record were the relations of research and the agricultural marketing act, the status of the agricultural experiment stations in 1928, the annual conventions of the Association of Land-Grant Colleges and Universities and other research groups, cooperation in agricultural meteorology, the establishment of an experimental institute of plant industry in India, and some current views of the history and trend of agricultural education. Still other editorials dealt with the services of D. W. May, for more than a quarter century director of the Porto Rico Experiment Station, and obituary notices of two former editors of the Record, namely, A. C. True, who was editor during the period from 1893 to 1899, and E. W. Allen, who served in that capacity during the ensuing 25 years. The influence of these two leaders upon the Record was both long continued and determinative. Doctor True personally being responsible for the system of classification of material and many other distinctive features and Doctor Allen especially for the enlargement and development of the monthly editorials as a means of making the Record not merely an abstract journal but an organ to serve the interests of the experiment stations by the periodic discussion of their current problems and needs.

The primary purpose of the Record is to review in a systematic and comprehensive way all the publications of the experiment stations in this country as well as all those of the Federal Department of Agriculture which are of general interest. During the past year 961 publications issued by the stations and 467 from the department were handled under a system of definite assignment and review and substantially upon a chronological basis, a service never attempted by any other agency, and one which increases steadily in importance and value with the passing of the years.

As a means of extending the availability of this material the plan adopted in 1928 whereby carbon copies of all abstracts of this class of publications were transmitted periodically to Biological Abstracts was continued, thereby advancing by several weeks their accessibility to the editorial staff of that publication. During the year about 200 of these abstracts were reprinted in Biological Abstracts and a few others by Social Science Abstracts, to which they had been forwarded by Biological Abstracts under an extension of the cooperative arrangement to permit of a wider utilization of the sociological material. The department representative of Biological Abstracts is F. V. Rand.

The total number of abstracts to appear in the Record during the year was 5,836. The individual abstracts were somewhat longer. This increase in length was due to various causes, the most significant

being the increasing proportion both in quantity and importance of the published work of the State experiment stations.

The increasing volume of the publications of the stations and the department and the precedence given to the reviews of this material in the Record have resulted in a corresponding reduction in the space available for abstracts from other sources. This situation impairs the completeness of the review and virtually precludes its logical extension to some of the newer lines of inquiry, such as textiles, clothing, and home management, which were largely unknown as subjects of inquiry when the present space limits were set for the Record in 1911, but are now being studied by research workers in increasing numbers both within and without the experiment stations. When, in addition, one considers the remarkable growth which has taken place in research in economics and sociology, genetics, and the fundamental basic sciences generally within this period, the difficulties of covering the expanded field in its entirety under the existing conditions appear well-nigh insuperable.

Notwithstanding these handicaps there are many evidences of a genuine appreciation of the work which the Record is attempting to do. For many years its free distribution has been necessarily restricted more and more rigidly to institutions and individuals directly engaged in agricultural education and research and related activities, but the demand has now become more widespread and varied. To cope with this situation, in many cases the policy has been adopted of establishing centers, such as libraries, agricultural schools, and similar agencies, at which the Record may be consulted with reasonable facility. There also has been a notable increase in the number of paid subscriptions, especially from commercial organizations, which like many other groups, including investigators, county agents, and other extension workers, writers, and teachers in schools of various grades, find its services increasingly useful both as a means of keeping abreast of current agricultural research and as a compendium of information on previous knowledge in the field.

A combined index, covering volumes 41 to 50, was submitted for publication during the year. This will greatly facilitate the use of the Record for the period 1919-1924. The preparation of a similar index for the ensuing 10 volumes also is actively under way, and it is hoped to issue these important aids thereafter at 5-year intervals.

LIBRARY AND BIBLIOGRAPHIC WORK

The activities of the library of the Office of Experiment Stations continued along the same lines as in previous years. This library is maintained primarily for the use of the personnel of the Office of Experiment Stations and the Office of Cooperative Extension Work. The rapidly expanding volume of published information in the different branches of agricultural science and extension have made a well-equipped and adequately staffed library an essential feature of these offices.

The fourth biennial supplement to the List of Bulletins of the Agricultural Experiment Stations was issued as Miscellaneous Publication No. 65 in January, 1930. A list, with index, also was compiled of the titles of circulars and series other than bulletins published by the State agricultural experiment stations from their estab-

lishment to January 1, 1929. It is estimated that this list and index will comprise approximately 150 printed pages.

Beginning with 1928 the articles published by station workers in scientific and technical journals have been listed on cards. During the year ended June 30, 1929, 2,000 articles appeared in 77 journals exclusive of the *Journal of Agricultural Research*.

Bibliographies and lists of references pertaining to extension work also have been compiled. The check list, comprising approximately 1,731 typewritten pages, of the State agricultural extension publications through 1929 was completed.

DEATH OF DOCTOR ALLEN

E. W. Allen, connected with the office since 1890 and its chief since 1915, died November 11, 1929. Doctor Allen brought to the service of the office an equipment of native ability, sound scientific training, high research ideals, and abounding energy, which, with ripened and well-balanced experience, peculiarly fitted him for his duties as chief of the office, and made him an outstanding and acknowledged leader in the organization and administration of agricultural research. His death was a great loss to the office and to agricultural research in general.

REPORT OF THE DIRECTOR OF THE EXTENSION SERVICE

UNITED STATES DEPARTMENT OF AGRICULTURE,
EXTENSION SERVICE,
Washington, D. C., September 20, 1930.

SIR: I present herewith the report of the Extension Service for the fiscal year ended June 30, 1930.

Respectfully,

C. W. WARBURTON, *Director.*

HON. ARTHUR M. HYDE,
Secretary of Agriculture.

PERSONNEL

The personnel of the Extension Service in Washington on June 30, 1930, consisted of 191 persons, of whom 7 were employed in the office of the Director, 134 in the Office of Cooperative Extension Work, 26 in the Office of Exhibits, and 24 in the Office of Motion Pictures. The field force on the same date consisted of 4,816 persons, of whom 4,800 were cooperatively employed by the department and the States in extension activities. The 16 field workers not cooperatively employed included 5 full-time employees of the Office of Cooperative Extension Work and 11 employees of the Office of Exhibits. In addition to the persons employed cooperatively by the department and the States, more than 1,120 were engaged in extension work in the States who are not under appointment from the department.

FUNDS ADMINISTERED

The direct Federal appropriation for the Extension Service during the fiscal year was \$1,753,615, of which \$1,495,000 was for farmers' cooperative demonstration work and motion pictures, \$12,000 for general administrative expenses, \$61,615 for the employment of extension agents in flooded areas, \$120,000 for exhibits, and \$65,000 for farm-forestry extension. In addition, Federal appropriations amounting to \$6,182,936 were allotted to the States and the Territory of Hawaii for extension work, under the terms of the Smith-Lever and supplementary acts, and \$1,480,000 under the terms of the Capper-Ketcham Act. The States, counties, and other agencies contributed \$15,006,040 for cooperative extension work. The total of all of these items to be expended for motion pictures, exhibits, and cooperative extension work with the State agricultural colleges was \$24,422,591.

COOPERATIVE EXTENSION WORK

PERSONNEL

The Office of Cooperative Extension Work continued under the direction of C. B. Smith as chief. During the year, J. A. Evans, who had been the assistant chief, was made associate chief, and T. Weed Harvey became assistant chief. Marcus M. Thayer, who had acted as administrative assistant was made business manager. On June 30, 1930, the Washington staff of the office comprised 9 administrative and supervisory officers, 13 organization field agents, 19 subject-matter field agents, and a clerical force of 93.

W. A. Lloyd, who had been granted a year's furlough to organize and direct the new extension work in the Territory of Hawaii, returned to Washington, October 24, 1929, and resumed direction of extension work in the Western States, which had been assumed by C. B. Smith during his absence. During the year, owing to the merging of the office of agricultural instruction with that of extension studies, E. H. Shinn and C. H. Schopmeyer were transferred to the latter office, and F. A. Merrill to the office of visual instruction and editorial work. H. M. Dixon, specialist in farm management, B. B. Derrick, specialist in cooperative marketing with the Federal Farm Board, and Eugene Merritt, field agent for the Western States, were transferred to the new section of agricultural economics extension.

W. K. Williams was appointed July 1, 1929, to the position of extension forester in the Washington office, this position having been vacant for over a year. In cooperation with the Bureau of Dairy Industry, three extension dairymen were employed. J. H. McClain in the Southern States, J. B. Parker in the Eastern States, and A. B. Nystrom in the Central States. F. C. Meier resigned as extension plant pathologist on January 31, 1930, to have charge of barberry eradication in the Bureau of Plant Industry and was succeeded by R. J. Haskell on May 16, 1930.

F. A. Anderson was made director of extension in Colorado on July 1, 1929. B. H. Crocheron, director of extension in California, was on leave during the greater part of the year studying the possibilities of marketing California surplus fruit in Asia. He returned to duty on May 1, 1930. L. B. Smith acted as director in his absence. H. C. Ramsower, director of extension in Ohio, was on leave during the year for advanced study, and George B. Crane was acting director in his absence. M. S. McDowell, director of extension in Pennsylvania was on sabbatical leave from January 1 to June 30, 1930, during which time J. M. Fry acted as director. S. B. Nelson resigned as director of extension in the State of Washington, January 31, 1930, and R. M. Turner has served since as acting director. Frederick G. Krauss succeeded W. A. Lloyd as dean and director of the Hawaiian Extension Service on October 24, 1929.

The entire field staff on June 30, 1930, numbered 5,942 persons, an increase of 251 during the year. Of this number, 4,354 were located in the counties, of whom 2,580 were in county agricultural agent work, 1,225 in county home demonstration work, 246 in boys' and girls' club work, and 303 in negro extension work. The county agents were supplemented in their work by 854 full-time and 246

part-time subject-matter specialists located at the State agricultural colleges. There were also 414 supervisors and assistant supervisors, and 74 administrative officers and immediate assistants. This represented an increase of 184 county workers, 4 administrative and supervisory workers and 63 subject-matter specialists in the field force. This increase in the county staff was divided among the following: 90 county agricultural agents, 38 assistant county agricultural agents, 3 negro county agents, 45 county home demonstration agents, 13 assistant home demonstration agents, and 2 negro home demonstration agents. The number of county boys' and girls' club agents was reduced by 7. Of these 5,942 persons, 4,800 were cooperative employees of the department, engaged either in county extension work, supervision of county work, farm-management demonstrations, farm-forestry extension, and other extension work.

FUNDS

The total funds available for cooperative extension work from all sources during the fiscal year were \$24,257,800, an increase of nearly \$1,340,000 over the previous year. Approximately \$274,000 of this increase was in Federal funds and \$1,066,000 in State and county funds. Of the total funds 38.1 per cent, or \$9,251,760, was contributed by the Federal Government, exclusive of the privilege of using penalty envelopes; and 28.6 per cent, or \$6,948,450, was from State appropriations to the agricultural colleges and other State agencies. The remaining 33.3 per cent, or \$8,057,590, came from county appropriations for extension work and from contributions by local organizations and individuals. About 95.4 per cent of all funds used for cooperative extension work in 1930 came from public sources.

Of the Federal funds, \$6,182,936 was made available by the Smith-Lever Act and an appropriation supplementary thereto, \$1,480,000 by the Capper-Ketcham Act, and \$1,588,824 from direct appropriations to the department. Of the total funds, \$15,373,200 (63.4 per cent) was allotted for extension agents in the counties; \$1,259,225 (5.2 per cent) was allotted to the State agricultural colleges for administration; \$2,505,853, (10.3 per cent) for supervision of county extension workers; and \$4,581,312 (18.9 per cent) for the employment of subject-matter specialists. About \$84,340 (0.3 per cent) was unexpended at the close of the year. The remaining 1.9 per cent, or \$453,870, was for activities of the Federal Extension Service at Washington, D. C.

PROGRAMS

GENERAL RESULTS ¹

During the last year special emphasis was placed upon the economic phases of extension work. The cooperation of the Extension Service with the Federal Farm Board caused more attention to be given to cooperative marketing and the adjustment of agricultural production to market demands. At all times the extension force cooperated closely with the Farm Board in efforts to create coopera-

¹ All extension field reports are submitted for the calendar year; hence, figures in this report on cooperative extension work, except where the fiscal year is indicated, are for the year ended December 31, 1929.

tive organizations, without assuming undue responsibility. Agents were very active in helping the farmer to obtain larger farm incomes and to raise materially his standards of living. During the year 929,744 result demonstrations were carried on that taught better practices and resulted in better living conditions. This was an increase of 78,218 over the preceding year.

Extension work in the field of farm management made marked progress. This activity has become a well-established part of the basic programs of most States. Much help has also been given farmers in establishing short-time credits wher soliciting loans by taking annual farm inventories and making out credit statements for the use of local banks.

Outlook information was used much more than in the past. Many States now publish regularly outlook information that extension agents interpret and apply for farmers. Farmers are rapidly being taught to use these reports in planning their farm operations for the coming year.

Conferences with farmers and demonstrations of best methods to pursue have been largely supplemented by bulletins, press releases, tours, and campaigns. The extent to which practices advanced have been accepted by farmers has increased markedly the past year. While some lines of extension work have decreased somewhat, because of successful acceptance of methods and procedures advocated, there can be noted a much wider activity in the extension field especially along economic lines. Considering all phases of the work, it is manifest that the extension program has become much better stabilized. While particular subjects have been minimized in one section of the country this condition has been balanced by increases in other sections.

In the field of rural recreation, the extension forces made marked progress. It is as much a part of extension work to teach people how to enjoy their leisure as it is to create this leisure by teaching them how to raise their incomes. With this idea in view, the Playground and Recreation Association of America assigned three of its staff to cooperate with the extension agents in various States to teach rural youths and adults how to play profitably. With the help of these workers, the extension force trained local leaders in many communities to carry on the work.

The extension agents had the assistance of 273,518 volunteer local leaders during the past year. These workers gave freely of their time and energy in the making of county programs, the training of leaders, in conducting demonstrations, and in helping agents in other ways. More than 200,000 of these leaders worked with adult farmers and home makers, while about 70,000 worked with the juniors. All these leaders were trained by the extension workers.

ACTIVITIES OF THE AGENTS

Most of the time of the agricultural agents was devoted to assisting farmers in crop production, in dairying, in animal husbandry, and in horticulture. More and more time is being spent in helping farmers plan their management project, and in interpreting outlook information for future use. Increasing emphasis is given to help-

ing farmers formulate plans for future improvements in the home and on the farm. Innumerable field meetings were held and articles written for the press. A brief synopsis of these activities shows the magnitude of the work. There were 1,546,677 personal visits made by agricultural agents to 793,688 farms; 423,600 news articles were written by agents and sent to the press; over 800,000 field meetings were held; 6,345,488 pieces of literature were distributed; and 3,403,028 calls by farmers were made at the offices of the agricultural agents.

The home demonstration agents spent much time in giving help in the making, care, and renovation of clothing. Foods and nutrition received considerable attention, as did better home-keeping methods. Home demonstration agents were helped by 88,719 local leaders. These agents made 377,858 farm-home visits to 223,406 farms and received 540,422 personal visits at their offices.

The county club agents were assisted in their work by 10,391 local leaders. They made 67,329 visits to 35,595 different farms. They received 14,606 office visits and prepared 14,486 news articles for the press.

BOYS' AND GIRLS' 4-H CLUB ACTIVITIES

Reports for the year 1929 indicate that of the 756,096 farm boys and girls enrolled in 4-H club work, 507,487 or 67 per cent satisfactorily completed their work in agricultural and home-making activities. These figures show a substantial increase over the preceding year, due largely to the use of funds made available through the Capper-Ketcham Act passed in 1928, in addition to a quickened interest on the part of many national organizations cooperating with the United States Department of Agriculture and the State agricultural colleges. The total number of result demonstrations conducted by those enrolled was 995,262 which was over 51 per cent of all demonstrations conducted in improved farm and home practices.

Parallel with this increase in production was a corresponding improvement in the quality of work exhibited by the 4-H club members reporting. Better educational methods were employed by both field agents and local volunteer leaders. In addition, the general 4-H club program was expanded to meet more satisfactorily the needs of country boys and girls. Reports show a sizable increase in the number of short courses at the colleges, summer camps, weekly and monthly club meetings, music appreciation programs, growth and posture work, community improvement activities, and other cooperative undertakings that are contributing to the all-round development of farm boys and girls into outstanding citizens. The influence of this work in relation to organized agriculture is immeasurable. Former club members are increasingly taking their places as officials of adult farm groups organized for various purposes, including cooperative marketing and general extension activities.

Encouraging progress was made during 1929 in interesting boys and girls in their later teens in the 4-H club program. The college short courses held especially for these young people were probably the outstanding development during 1929. Reports indicate that a much larger number of this age group were enrolled in club activities than in any previous year. In addition to meeting the social needs of

these older boys and girls, gratifying results were obtained through the plans followed to meet the economic needs of these young people. Attention was focused in the club program upon the values accruing from property and personal insurance, establishment of credit, and the maintenance of satisfying minimum living standards from the standpoint of cash needed to start farming either as a farm owner or as a tenant.

EXTENSION STUDIES

FIELD STUDIES

During the year the sections of agricultural instruction and extension studies were consolidated, the new division being known as extension studies and teaching. The scientific personnel of the division consists of M. C. Wilson, in charge; E. H. Shinn, senior agriculturist; C. H. Schopmeyer, senior agriculturist; and J. M. Stedman, associate agriculturist. It is expected that, while many of the duties of the section of agricultural instruction will be continued, more attention will be given to field studies and to the development of training courses for professional improvement of the extension personnel.

Four new extension studies were made during 1930 in South Carolina, Missouri, Kentucky, and New Jersey. As studies have been previously made in New Jersey, three new States have been added to the list of those cooperating with this office in making organized studies. This makes a total of 25 States in which the farm and home surveys and other studies of the division have been made to date. The South Carolina study relates to the home-garden project as carried on by home demonstration workers.

The kitchen-improvement extension program was the subject of the studies in Kentucky and New Jersey. In Missouri factors that influence attendance at and effectiveness of extension meetings are being studied. Studies of the membership of home demonstration clubs and the problem of reaching those who have not joined such clubs have also been made in South Carolina and Kentucky.

Nine hundred and ninety-two records were obtained during the year, 15,941 farm, home, and leadership records having been taken to date. Twenty-nine additional members of the State extension services and two additional members of the staff of this office have participated in the collection of extension research data by the survey method.

The information obtained from the 326 local extension leaders in Kansas and Nebraska last year has been summarized, and reports have been prepared for distribution to the field. For the first time detailed information is available on the extent to which local leaders engage in leadership activities and the amount of time required by each. In the areas studied in Kansas and Nebraska, the average local leader devoted 16 days per year to leadership work. Activities requiring more than one day each are: Attendance at leader training meetings; preparation of subject matter in connection with its presentation to others; presentation of subject matter by means of method demonstration meetings; and assisting with extension exhibits. Further studies of local leadership will have to be made in

order to bring out the relative importance of the various leadership activities.

Comparing the effectiveness of local leadership in the New Jersey, South Dakota, Kansas, and Nebraska areas in terms of number of people influenced to adopt recommended practices and number of practices changed as the result of leaders' efforts, practically the same percentage of leaders in each of the four areas passed on information to others, the highest being 87 per cent in the New Jersey area, and the lowest, 84 per cent, in the Nebraska area. There is also remarkable uniformity in the number of farmers or home makers influenced to adopt better practices, the range of variation being from 11.7 in Kansas and South Dakota to 13 in New Jersey. There is greater variation in the number of practices changed as a result of the work of each leader, largely due to the different units into which the subject matter was divided for passing on by local leaders in the four areas.

The fact that about 86 per cent of all local leaders may be counted on to pass on information to others and that about 12 persons are influenced per leader on the average, regardless of variation in the use of local leaders in the four areas studied, suggests the possibility that these figures may represent the normal contribution of local leaders to the advancement of the local extension program. The great uniformity in the average number of persons influenced per leader in the four areas studied indicates that perhaps greater progress may result from the establishment of new circles of influence around new leaders than from attempting to increase the size of the circles of influence of old leaders.

The general study of the effectiveness of extension in Hamilton County, Nebr., field data for which was obtained last year, has been completed and the results published by the Nebraska Agricultural Extension Service as Extension Circular 25, Extension Results as Influenced by Various Factors. For purposes of comparison, information for 16 other areas in which studies have been made was presented alongside the information from the Nebraska area. With regard to the farms and homes making use of extension information, the Nebraska area studied compares favorably with similar areas studied in 16 other States.

At the request of Dean Russell, of the College of Agriculture, University of Wisconsin, the Secretary of Agriculture approved a plan whereby the head of this division organized and conducted a 6-week course for experienced extension workers at that institution during the 1929 summer session. Thirty-one students enrolled for the course. These students came from 12 States—Maryland in the East; Arkansas, Mississippi, and Oklahoma in the South; Ohio, Illinois, Missouri, Kansas, Minnesota, and Wisconsin in the Central States; and Colorado and Montana in the West. Of the 31 students enrolled, 27 were men and 4 were women. Twenty-one of the 31 were experienced extension workers, 7 were agricultural teachers, 1 a home-economics teacher, and 2 were employees of the State department of agriculture. Of the 21 extension workers, 8 were county agricultural agents, 3 home demonstration agents, 5 supervisors of county extension work, and 5 were subject-matter specialists. Twenty-eight of the 31 took the course for credit, 20 of them for graduate credit. The remaining 3 were enrolled as auditors.

College and university authorities were so impressed with the value of the course and with the interest shown by the members of the class, that plans have been made to repeat it during the 1930 summer session. A more advanced course will also be offered for those taking the 1929 course and for others with suitable extension experience.

Though some 21 of the State colleges are giving extension-training courses to undergraduates interested in entering the extension profession, the 1929 summer course at Wisconsin was the first in extension methods carrying graduate credit. Following the beginning made at Wisconsin, Cornell and Ohio are both offering extension courses of graduate rank for extension workers at their 1930 summer sessions. It is hoped that at least one institution in the South and one in the far West also will start similar courses for the professional improvement of extension workers.

The next logical step is the development of a comprehensive plan for graduate research in extension. A group of experienced extension workers engaging in research in their own profession will rapidly add much to the knowledge of extension. This division could profitably cooperate with such students working on extension problems in connection with work for an advanced degree.

SUMMARY OF REPORTS

The 1929 statistical summary of extension accomplishments prepared by the division contains information from the reports of 3,999 county extension agents who were assisted by the equivalent of 968 full-time subject-matter specialists. This is an increase in the number reporting over the previous year of 317 county workers and 58 specialists.

The various subject-matter lines of work continued to receive the same proportion of extension time as in previous years. During the 6-year period, 1924-1929, there was little, if any, shift in extension emphasis in the country as a whole so far as subject matter is concerned.

Since the ultimate objective of extension teaching is to bring about improvement in agriculture, home economics, and rural life through changed farmers and farm women, the extent to which rural people have been influenced by extension activities to make changes in farm and home practices presents the best single picture of the results of extension effort.

The number of instances of the adoption of better practices by farmers and farm women reported by all extension agents in 1929 was 5,170,343, or 508,246 more than in 1928.

FARMERS' INSTITUTES

Eleven States reported farmers' institutes conducted as a state-wide activity during the year ended June 30, 1930. A total of 2,600 institutes were conducted, extending over a period of 3,941 days, and 9,029 sessions with an attendance of 1,266,484 persons. The instruction at these institutes was given by 729 persons, of whom 85 were members of the extension services, 60 were from experiment stations, 27 from State departments of agriculture, and 339 from outside sources.

VISUAL INSTRUCTION AND PUBLICATIONS

An improvement in the presentation of subject matter, the more liberal use of suitable illustrations, and a trend toward brevity of expression characterized extension publications during the past year. Over 6,000,000 publications were distributed by the extension forces during 1929. In that year, 1,709 printed documents were issued. These consisted of 242 bulletins, 366 circulars and 1,101 miscellaneous publications. The Office of Cooperative Extension Work issued two large reports and 11 printed circulars relating to certain phases of extension activities. Twenty-three mimeographed circulars were issued in the regular series and 221 were prepared as various extension subjects.

PUBLICATIONS

Seven new publications and 31 illustrated charts were prepared by various members of the staff of the Office of Cooperative Extension Work, printed, and issued during the fiscal year, as follows:

Report of the Director of the Extension Service, 1929; Miscellaneous Publication 36, A History of Agricultural Education in the United States, 1785-1925; Miscellaneous Publication 52, How to Find Economic Facts and Apply Them as a Basis for Extension Programs in Home Economics, Dairying, and Forestry; Miscellaneous Publication 72, Lantern Slides and Film Strips of the United States Department of Agriculture; Circular 43, Home Demonstration Work Under the Smith-Lever Act, 1914-1924; Technical Bulletin 125, Relative Costs of Extension Methods Which Influence Changes in Farm and Home Practices; Cooperative Extension Work, 1927; range-livestock material for Extension Service Handbook; 31 illustrated charts.

Department Circular 251, Federal Legislation, Regulations, and Rulings Affecting Land-Grant Colleges and Experiment Stations, and Department Bulletin 863, Forestry Lessons on Home Woodlands, were revised and printed.

Cooperative Extension Work, 1928, was in press at end of the year.

The following popular publications were reprinted to supply the demand for copies from extension workers:

Miscellaneous Circular 77, Boys' and Girls' 4-H Club Work; Miscellaneous Circular 85, Boys' and Girls' 4-H Club Work under the Smith-Lever Act, 1914-1924; Circular 57, The Rural Church and Cooperative Extension Work; Miscellaneous Publication 35, Cotton or Weevils; Department Circular 385, How to Prepare and Display Extension Exhibits; and Technical Bulletin 106, Extension Methods and Their Relative Effectiveness.

The following 16 contributions were made by the staff to the series of mimeographed extension service circulars:

No. 110, Foreign Agricultural Extension Activities; No. 111, Home Economics Extension Work; No. 112, Possibilities and Limitations of Assistance to Cooperative Associations by the Extension Service; No. 113, The Significance of Vocational Training in a State Program of Negro Education; No. 114, Foreign Agricultural Extension Activities; No. 115, What Local Leaders Do; No. 116, Leave for Professional Improvement; No. 117, Extension Work in Cooperative

Marketing; No. 118, What Local Leaders Do: Kansas; No. 119, Foreign Agricultural Extension Activities; No. 120, Farmers' Institutes, 1929; No. 121, Rewards of Leadership; No. 122, Extension Service Circulars of the United States Department of Agriculture—Numbers 1 to 121, inclusive; No. 123, Foreign Agricultural Extension Activities; No. 124, Statistical Results of Cooperative Extension Work, 1929; and No. 125, How to Organize a County Agent's Office.

On May 1, 1930, the Extension Service started a monthly publication known as the Extension Service Review. For many years a need has been felt for just such a publication, but until very recently it had been impossible to obtain the necessary finances. This periodical is sent free to all extension workers and is planned to carry to them the latest news concerning extension achievements and methods. The publication consists of 16 pages of print, census size, and colored cover, and is issued monthly throughout the year. Illustrations are used liberally, and every effort is made to issue an attractive as well as a valuable publication. Thus far the review has met with much commendation from the field.

INFORMATION

Increased interest was shown in the development of the news service during the past year. Much assistance was given county agents to enable them to improve their service to local newspapers. The mimeographed pamphlets formerly issued to the 4-H club and to the home demonstration workers were suspended, the Extension Service Review taking their place.

County agents report the preparation of 423,600 news stories for the press during 1929. A complete record of the number of articles prepared by State extension divisions is not available. The Office of Cooperative Extension Work cooperated in preparing 63 articles for the Official Record and for press releases.

Continued increase is noted in the preparation and furnishing of photographic illustrations to the department press service and to the field. The demand for department illustrations for commercial and private use is continually increasing.

The fourth national 4-H club camp called heavily upon the news service of this division. A daily mimeographed sheet was issued and hundreds of press releases sent out. Each State represented at the camp furnished a list of local papers, which were sent news items as rapidly as they were gathered. During the week 20 stories were telephoned to reporters and correspondents, 7 stories were furnished representatives of various farm journals, and about 130 photographic prints of camp activities were sent to extension editors of States having representatives at the camp. The delegates to the camp prepared personally 45 articles which were used either in the camp daily or in some local paper.

VISUAL INSTRUCTION

Cooperative field work with the States in visual material was developed to a greater extent than ever before. This consists mostly of series of photographs on organized subject matter. Work similar to that done in Maryland and Virginia the preceding year was done

in Virginia, Maryland, Texas, and North Carolina. Interesting series of photographs were made in North Carolina of feeding hogs, dairying, and cheese making. Various State extension divisions expressed strong desires for such series.

Exhibits for county, State, and interstate fairs were planned in all cases to present extension activities definitely and attractively. Motion was employed in many demonstration exhibits. The Office of Exhibits cooperated with the Office of Cooperative Extension Work both in general exhibit work and in the preparation of 4-H club exhibits for showing at the Eastern States Exposition held at Springfield, Mass.

County agents reported using lantern slides and film strips at 7,747 meetings. Over 4,100 copies of department film strips were purchased by agents. During the year 19,117 meetings were held, at which motion pictures were used. Twenty-three new motion pictures were provided for use in the field, including such subjects as cooperative marketing, forestry, animal husbandry, soils, home management, and health.

Eleven States were visited by the personnel of the division of visual instruction and editorial work during the year to give help in the use of visual aids. That division cooperated with the State forces in securing 2,133 field and 389 laboratory photographs. More than 57,000 prints, slides, and enlargements were made, and many drawings were requested and prepared. In addition to this work, one lantern-slide series and one film-strip series previously prepared were revised.

RADIO²

Extension broadcasting in cooperation with commercial stations was more highly developed during the year than at any previous time. An effort is being made to correlate Federal and State broadcasting. The introduction of the national farm and home program was a step in this direction, and further advance was made when the National Broadcasting Co. accepted a monthly 4-H club program as a part of the farm broadcast. This club program occurs the first Saturday of each month at 12.30 p. m., eastern standard time.

In most club programs a boy and a girl representing the best of club activities take part. These participants are selected from different States each time so that the work may be comprehensively represented. Besides the young people, an extension agent and a local leader generally appear. The broadcasting talks are interspersed with musical selections, often rendered by the United States Marine Band or by artists supplied by the National Broadcasting Co. from its Chicago studio. Fourteen States have been represented thus far. Another prominent radio feature of the year was the broadcast from the National 4-H Club camp during the latter part of June, 1930.

Except for special occasions such as this, it is the aim eventually to share all broadcasting time made available to the department by commercial stations with individual State extension departments. In this way, both national and local information may go on the air during the same period.

² See report of the Director of Information for 1930.

SUBJECT-MATTER FIELD AGENTS

The group of subject-matter specialists continued in charge of A. B. Graham. The department extension specialists make contacts with State subject-matter specialists having corresponding lines of work. During the year increased effort has been made to reach more people and to assist in establishing the best methods of teaching adults. To learn what the department investigators have determined that may be ready for extending, and that the Office of Cooperative Extension Work may become better acquainted with the work of the department, the weekly conference conducted by this group was continued through the fall, winter, and spring months.

An extension forester and two extension dairymen were appointed at the beginning of the year. An extension home economist, representing the Bureau of Home Economics and the Office of Cooperative Extension Work, was added in February. The extension economist in cooperative marketing was transferred to the Federal Farm Board, but still represents the Office of Cooperative Extension Work in its cooperative marketing interests.

The members of the specialist group assist in the preparation of visual teaching material, such as lantern slides, movies, charts, photographs, and folders, to be distributed or loaned to State extension services desiring such material. Statistics as to State and national agricultural conditions are prepared in cooperation with State extension forces.

AGRONOMY

During 1929 the agronomy work was carried on in 43 States with 97 specialists. Five States, Delaware, Rhode Island, Florida, Mississippi, and Nevada have no specialists in this line of work. However, in each of these States some one, usually the vice director or county agent leader, has handled agronomy extension so that some work has been carried on in every State.

Of the 97 specialists in 43 States, 84 are on a full-time basis and 13 on a part-time basis. Twenty-three States have 1 specialist each, 7 States have 2 specialists each, and the other 13 States have 3 or more, the largest number being in Michigan, with 11 specialists covering the soils and crop program. In this State, however, the program covers not only grain and legume crops, but also potatoes and sugar beets.

During 1929, as has been true in the last several years, the crops program has centered very largely around a crop-production and a seed-improvement program, the two being so closely associated that in most States it is really just one big project—that of crop production, either for the use of livestock on the farm or to be sold for cash.

The crop-production program divides itself into pasture, grain, and forage crops. During the past year, there has been an increased interest in pasture improvement and this work has been carried on in 33 States, in most of which it has been one of the major projects. Kentucky reports 758 pasture demonstrations, Pennsylvania reports 161, and Massachusetts 67. This indicates something of the interest taken in this project.

In the forage-crop program, projects on general hay production were carried on in only eight States, while work with legume crops was very general. Alfalfa demonstration work was carried on in

40 States; sweetclover work in 30; soybeans in 18; Lespedeza in 11; clover, principally red clover, in 19; while other miscellaneous crops such as vetch, field peas, velvetbeans, and peanuts were reported in 10 States.

Seed-improvement work is still probably the most important project in agronomy, as it is used as the basis for crop-standardization work in many of the States, and the extension agronomists are coming to realize that their time is wasted in encouraging farmers to improve crop conditions unless they also see to it that reasonable supplies of good seed are easily made available for use. This year there are 25 active State seed-improvement associations, and 2 more are being organized, 1 in Kentucky, and the other in Louisiana. The principal crops that are receiving attention in the seed-improvement program are corn, wheat, oats, barley, and rye, with alfalfa as a special crop in the States of North Dakota, South Dakota, Montana, Wyoming, Idaho, and Utah.

Corn improvement is reported in 35 States, and in most of these reports indicate that there is sufficient certified corn available, either direct from the certified fields or only one or two years removed from certification, to supply every farmer in the State who desires improved seed corn.

Seed-improvement work with small grains is reported as follows: Wheat in 32 States, oats in 35 States, barley in 26 States, and rye in 12 States. In a majority of States where small grain is being handled in cooperation with seed-improvement associations it is now possible, as it is with corn, to supply any farmer desiring improved seed with the best adapted seed that can be grown, and this is used as a basis for the crop-improvement program in the State.

Weed control is becoming one of the important projects and was reported as an active line of work in 21 States in 1929. In 18 of the 21 States weed control by means of chemicals was reported. This work during 1929 was greatly increased because of the activity of commercial firms in the demonstration and use of chemicals for the control of noxious weeds. In all but one of the Western States weed control was one of the principal projects, and not only cultural methods but chemicals were used in the control of weeds. Irrigation is one of the most serious sources of weed distribution, and the farmers have been quick to recognize the value of chemicals in the control of weeds along ditch banks and in irrigation areas.

Potatoes were reported as an active agronomy project in 17 States. In some of these States the work was carried on by special potato men in the agronomy work; in others it was carried on by the regular extension agronomist as a side project along with other crops. Cotton-improvement work was reported in 10 States and tobacco work in 7. In all these States, with cotton, tobacco, and largely with potatoes, the work was along the line of seed improvement.

Some work was carried on in North Carolina, South Carolina, and Georgia on the improvement of cottonseed. Surveys have indicated that in these States not more than 25 to 33 per cent of the cotton used in the mills is produced locally. The mills are using long-staple cotton of from 1 inch to 1½ inch, and most of the cotton produced in these States in the past has been short staple. This fact has made it necessary for the mills to ship in their long-staple cotton from

Mississippi, Texas, or other States farther west, and the local short-staple cotton has largely been exported at a much lower price than the long-staple cotton will bring. Active campaigns for the production of improved seed of the longer staples were carried on in all these States, and reports indicated that they were getting excellent results.

Soil-improvement work has centered during the past year around four major projects—the use of fertilizers, lime, green manure, and the control of soils.

Work with fertilizers has been reported from 40 States for the past year. As in the past, this has been largely along lines looking toward the use of high-grade fertilizers. In some instances formulas for home mixing have been developed and used in winter meetings, demonstrations, and the like. In other States there has been work with fertilizer interests in developing standard formulas for the use of high-analysis fertilizers and in reducing the number of formulas of the fertilizers offered for sale by commercial agencies.

Work with lime is reported from 28 States. This continues to be not so much demonstrations that show the value of lime as helping farmers to obtain more easily supplies of lime by means of better freight rates, pooling orders to permit carload shipments, and the use of community crushers and lime bins. A new phase of the lime program that is very interesting has been developed during the past few years in Illinois. The county agent, cooperating with the soil specialist, holds a series of training schools for project leaders in soil testing.

The handling of soil, including rotations and tillage, terracing, irrigation and drainage, and control of moisture are without doubt an important phase of soil improvement. They have, however, received a very small amount of attention from the agronomy specialists this year. Reports indicate that in 24 States work was done on rotation and tillage, in 9 States work on terracing, in 2 States work on irrigation and drainage, and in 4 States work on conservation of moisture. It is true, of course, that the work with green manures is a great help in soil conservation, especially in areas where the percentage of organic matter is very small and the soils are subject to winter erosion. There should, however, be much greater interest in terracing and moisture control than there has been in the past, and during the coming year efforts will be made to increase interest in this phase of the agronomy program.

HORTICULTURE

The horticultural extension work is growing faster than trained men can be found to fill the positions available. The two lines which expanded the most were home gardening and landscape work. These activities were largely taken over by home demonstration agents, particularly in the South, and throughout the country the farm women did more home gardening and yard improvement than the men. In some States the 4-H clubs did considerable home-garden work and some fruit work. The number of specialists increased from 96 in 1928 to 102 in 1929. Of these, 75 were on full-time and 27 on part-time work. The States having the most specialists were New York and Ohio with 8 each, Pennsylvania and Michigan with 6 each, and

Iowa and Virginia with 5 each. Florida, Maine, Rhode Island, New Mexico, and Wyoming each had only 1 specialist on part time.

The fundamental practices in horticulture do not change much from year to year, and the same lines of work were continued in 1929 with few changes. In fruit growing, orchard management included culture, fertilizing, cover crops, pruning, fruit thinning, spraying, rodent control, and top grafting. Considerable crop-cost accounting was done, and grading, packing, and marketing received more attention than ever before.

The work with vegetables included the use of certified seed, plant-growing glasshouses, earlier planting of canning-crop tomatoes, standardized grades and packs, selection of better varieties, better equipment and remedies in insect and disease control, more intelligent use of fertilizers, improved marketing methods, and planting and care of gardens.

There were more calls for help in connection with home gardens than for anything else except home-landscape improvement. Many of the vegetable specialists cooperated with the home agents and nutritionists, and through the activities of women's clubs and junior clubs the number of home gardens increased by thousands; not only summer gardens but also all-year gardens. A few figures on demonstration and club gardens mostly carried on by women and girls are: 15,868 in Texas, 12,004 in Mississippi, 10,788 in South Carolina, and 6,310 in Alabama. Of these, 9,821 were all-year or winter gardens. In South Carolina complete records were kept on 231 gardens averaging half an acre in size which produced crops sufficient to feed 1,297 people, to serve 207,592 times, and to can 33,780 quarts, and yet to leave a surplus which sold for \$21,354.37.

In horticultural extension work no more rapid progress was made than in the beautification of home grounds. In Missouri, 2,620 homes of white people and 1,500 homes of negroes were beautified, and the white people adopted 16,590 practices on the grounds around the 2,620 homes.

In California cost-accounting studies in orchards and vineyards were continued. Studies were made in 307 almond and Persian-walnut orchards; in 318 orchards of apples, pears, peaches, prunes, apricots, and cherries; in 77 orchards of oranges, lemons, and grapefruit; and in 93 vineyards. Studies in peach production were made in Kentucky and Georgia.

The sweetpotato work in South Carolina was conducted as a contest in which complete records of the cost of production were kept by 170 growers, and the awards of prizes were made on the yield of United States No. 1 grade grown by each contestant. To have a fair basis for deciding who were prize winners, the extension horticulturist and those helping him dug 50-foot pieces of five rows in different parts of the field and graded for yield of United States No. 1's.

The number of adult demonstrations carried on with tree fruits was 12,092; with bush and small fruits, 1,779; and with grapes, 1,511. Agents taught 10,720 farmers to plant improved varieties of tree fruits; 18,085 adopted better pruning methods, and 31,545 sprayed their tree fruits or treated them in some other manner for disease or insect pests. A total of 67,529 different farmers accepted better

practices in growing tree fruits; 10,720 in growing small fruits; and 10,103 in growing grapes.

Reports indicated that 5,989 demonstrations in market gardening were carried on with adults and that the activities of the agents caused 8,120 farmers to plant better stock or improved seed, and 10,722 to spray or otherwise treat for disease or insect pests. A total of 25,368 farmers adopted better practices in market gardening.

Adults, most of them women, carried on 40,898 demonstrations. Boys' and girls' club members completed 46,355 projects in home beautification. Altogether, 112,533 farm women and men put into practice the information on planting of shrubbery, shade trees, lawns, flowers, and other methods of improving the appearance of the farm home which they obtained from extension workers.

FORESTRY

Utah, Oklahoma, Hawaii, and Porto Rico began forestry work during the year, making a total of 32 States and 2 Territories co-operating under section 5 of the Clarke-McNary Act.

The forestry work during 1929 embraced such major projects as planting, improvement cutting, timber estimating, fire prevention, and 4-H club work in forestry. Other important phases which were emphasized in several States were marketing, sawmill improvement, and maple sirup production. Forest tree planting was the most popular work conducted last year, as it was the only phase of farm forestry being extended in some form in all States having extension foresters. It was the principal project in five mid-Western States where windbreaks and shelter belts are needed on most farms. Forest planting also comprises the greatest farm forestry need in both Hawaii and Porto Rico.

In the Eastern States planting was mostly done for the production of saw timber and pulpwood, whereas in the Southern States the planting of trees was done for the purpose of producing saw timber, fence posts, and other products for farm needs. Planting stock during the past year was obtained largely from the 36 State forest nurseries cooperating with the United States Forest Service under section 4 of the Clarke-McNary Act. These nurseries furnished state-grown tree seedlings at a nominal price to farmers. The colleges of agriculture or the agricultural experiment stations produced the trees in 9 States, and in 12 States all the tree seedlings grown by the States were planted exclusively on farm-owned lands.

Forestry 4-H club work with boys and girls has progressed with marked success in 23 States, an increase of 6 States over the number carrying this phase during the previous year. Forestry-club projects are designed to give a very interesting insight into the elements of forestry. Simple projects covering such subjects as tree identification, planting, estimating, and improvement cutting have been worked out in a manner which has proved very attractive to club members in a number of States.

Practical lessons to apply on the home woodlands were emphasized in most of the States. This work has been drawing the interest of an increasing number every year, and more completions are also being recorded. Four-H club forestry work has been an outstanding feature of the forestry-extension program in New Jersey, New York,

Louisiana, Wisconsin, New Hampshire, and Michigan. Such events as 4-H camps, contests, club weeks, pageants, demonstrations, posting fire signs, hikes, rallies, tours, field days, club meetings, and Arbor Day observance were used successfully in stimulating interest among the boys and girls.

Forest plantings were established on 5,334 farms, and windbreaks were planted on 3,088 farms according to methods advocated by the extension agents. Windbreaks and shelter belts were given much attention in the mid-Western States; planting for fence posts was given much attention in the southern region; and plantings for producing saw timber and pulpwood received emphasis in the Northeastern States.

PLANT PATHOLOGY

An important activity during the year was the prevention of disease in practically all leading crops. The control of corn root rot was emphasized in the extension program in the corn-producing States. The introduction of disease-resistant and disease-free seed occupied much attention in vegetable-growing sections. In the Cotton Belt, the advantages of wilt-resistant types of cotton were presented. Cereal-seed treatment, certified seed-potato production, potato-seed treatment and spraying, and orchard-spray service continued to be the outstanding projects in a number of States.

In 1929, 21 States reported work in the control of grain smut in connection with their crop-improvement program. In a number of States where there was no extension pathologist the work was carried on by the extension agronomist.

Improved or certified potato seed was planted by 30,033 farmers; 31,545 treated fruit trees for disease and insect pests; 43,127 sprayed for the protection of vegetables from disease and insects.

RODENT CONTROL

The rodent-control work of the Bureau of Biological Survey is so closely connected with rodent-control activities of the Extension Service that it is difficult to separate that done in cooperation with extension workers from the bureau total.

The Biological Survey supervised organized rodent-control operations in 27 States and educational work in 5 others during the year. On 19,245,000 acres of land 3,718,000 pounds of poisoned bait, 106,000 pounds of calcium cyanide, and 411,000 pounds of carbon disulphide were used. Seventy-five thousand ounces of strychnine used in poisoning bait was purchased through the bureau from manufacturers at a saving of approximately \$40,000.

Under its leadership in rodent-control work the Biological Survey, with the help of extension workers, has obtained the cooperation of many thousands of farmers and other landowners. During the year more than 99,000 farmers cooperated to obtain relief from rodent pests. The destruction of certain rodent pests on millions of acres of valuable agricultural land has caused an enormous direct saving and an increased production of important crops.

Extension agents reported that 9,451 adult demonstrations were conducted during the year and that control measures were adopted on 106,511 farms.

ENTOMOLOGY

Practically every State is carrying on extension work in entomology. Eighteen States employ full-time specialists, and entomologists devoting part of their time officially to extension work along this line are functioning in seven additional States. Four States employed three full-time men and two other States employed the equivalent of two full-time men in this work. In the United States the equivalent of 33 full-time men are acting as subject-matter specialists in entomology.

The outlining of a well-organized and continuous program of work has been interfered with materially by sporadic outbreaks of very destructive species of insects. This sporadic feature has been overemphasized and in many States the extension entomology work is now crystallizing around the control of those insects which are a more or less permanent factor in the production of the major crops of these States.

Timely informational services were one of the most successful lines of extension work in entomology. These were exemplified in the orchard-spray services of such States as New York, Pennsylvania, West Virginia, Maryland, and Ohio, where, through field observers, the subject-matter specialist was informed daily as to the progress in the development of the more important orchard pests. Through telephone relays and other means of immediate communication, he notified the orchardists exactly the time that certain remedial measures should be applied to be most effective.

The efforts of extension workers through 6,899 demonstrations and other supplementary methods of extending improved practices influenced the adoption of practical control methods for grasshoppers and other insect pests on 70,650 farms.

The chief problem of the extension entomologist in Louisiana was boll-weevil control. A very highly successful cotton-dusting program was employed. Over 5,000,000 pounds of insecticides were sold during 1929 as compared with 2,500,000 pounds in 1928. During the farmers' short course the extension entomologist gave lectures and put on demonstrations before the students, and attended nine meetings with an attendance of 650. Fourteen demonstrations other than cotton dusting were staged with an attendance of 410.

The beekeeping work in Louisiana is under a specialist in apiculture. The extension beekeeper visited 124 beekeepers and assisted in introducing 180 purebred adult Italian queens. He visited 59 schools and gave lectures to over 8,000 school children on the life of the honeybee, and attended 21 meetings with an attendance of approximately 2,000 adults to stimulate interest in beekeeping. The boys' and girls' beekeeping clubs added 192 members during 1929.

Extension agents in the United States reported that 1,220 adult demonstrations in beekeeping were conducted during the year, that 740 junior projects in beekeeping were completed, and that nearly 5,000 farmers adopted the methods recommended by the agents.

ANIMAL HUSBANDRY

During 1929 returns to the producer from livestock farming and ranching operations were generally satisfactory, although prices of wool and lambs suffered some decline. Constructive extension activity was encouraged by this situation. The most significant development of the year was the progress made in the long-time programs of improvement in livestock production. The general objective of these programs was to direct the use of domestic animals so as to convert more efficiently the raw products of the farm and certain by-products of industry into necessities of human welfare, and to conform as nearly as practicable to the demands of consumers in the quality and quantity of products and in the time the products are placed on the market.

New information on the geographical distribution of the Nation's livestock income served to indicate the importance of the livestock industry as a source of national wealth, as well as its importance by regions and individual States. These data show that livestock producers received an income of more than \$2,500,000,000 from the sales of meat animals, meats, and wool in 1928. This total would be still larger if it included the income from sales of horses, mules, goats, and mohair, as well as the sum of \$305,000,000 which is estimated to represent the value of meats slaughtered and consumed on farms annually. Of this total income, that received by hog producers was almost equal to the combined total received by cattlemen and sheepmen, only 11 per cent of the aggregate being received by the sheep industry.

The general tendency to complete the preparation of livestock for the slaughter market nearer the place of production was evident throughout most of the country. This change was being brought about by the increased production of fattening feeds such as grains in the West, by the improvement of ranges, the increasing and bettering of pastures, and the development of more local markets.

The preference on the part of the consuming public for smaller cuts of meat had an influence on production practices by encouraging the marketing of animals at lighter weights and younger age. Evidence of this influence was observed in both the range and the farming areas. It affected types of both sheep and cattle as well as feeding and management practices.

A popular line of work with beef cattle in the farm States was the herd demonstration in which breeding, feeding, and management practices were involved. Most of the effort was directed toward the production of baby beeves. Many steer-feeding demonstrations, both in dry lot and on pasture, were conducted as a help to those who purchase their feeding cattle. In the range area, proper management of animals and the range was one of the major activities. Supplemental feeding, feeding for market, culling, and selection of breeding stock also received considerable attention.

In the farm States preferred attention was given to such practices as the use of good purebred rams, creep feeding of lambs, treatment for stomach-worm infestation, docking and castration of lambs, proper winter feeding and care of the breeding flock, and grading for market. Culling of the breeding stock, supplemental feeding,

and proper range management were emphasized in the range States. In those areas of the West where surplus feeds were available the feeding of lambs for market was a leading demonstrational activity.

County extension agents reported that 235,136 farms had adopted improved practices in livestock production during the year as compared with 223,554 in 1928. This increase applied in about equal degree to all classes of farm animals. In the feeding of better-balanced rations for the first time the records show for 1929 that 46,858 farmers adopted better practices, an increase of more than 11,000 over those who adopted them in 1928. The number of farmers assisting in obtaining purebred sires during the year was reported as 26,044. This is a slight increase over the figure for 1928. In junior 4-H club work the number of animals involved in 1929 was 129,984, as compared with 117,958 in 1928.

DAIRYING

During 1929 more constructive effort was expended in the development of well-rounded dairy extension programs than in recent years. The problems facing the industry were studied closely, and the program was so developed that it would meet the immediate situation and at the same time fit in with the long-time development program intended to reach the greatest possible number of dairymen.

In the past the dairy extension programs centered generally around four main lines of effort: (1) Better breeding; (2) better feeding; (3) testing, and (4) 4-H dairy clubs. During 1929 the programs in several States were rounded out by the beginning of definite projects with both adults and 4-H club members on the improvement of the quality of milk and cream. This activity was an advanced step carried out with the proper use of modern extension methods and was expected to reach a large proportion of the dairymen and to result in marked improvement in the quality of the product.

The great market-milk territory in the East was faced with the possibility of a shortage during the fall and winter months of 1929, and extension programs were changed to meet the problem. The fact that there was no milk shortage may or may not have been the direct result of the extension projects, but it is safe to say that they played a part in preventing a shortage.

The expansion and development of dairying in the South caused more and more of the product of dairy cows to be sold for the manufacture of butter, cheese, condensed milk, and milk powder. As prices paid by dairy manufacturers were far below those paid for milk and cream to be sold for fluid consumption, economy of production became the most vital problem of successful and permanent dairying. The solution of this problem lay primarily in making the keeping of dairy cattle a part of a well-rounded system of farming—a system that would provide through proper rotation an abundance of pasture grasses, leguminous hays, and succulent feeds in the form of silage and soiling crops. Economy of production can not be achieved without these feeds as they are the basis of the best and most economical feeding practices.

As the most practical and rapid way to solve the problem of low-producing cows, extension agencies advocated the introduction

of purebred dairy bulls. The outstanding method of this introduction was the cooperative bull association. In seven Southern States on December 31, 1929, there were 127 such associations with 4,025 members who owned 573 bulls and 20,360 cows. Bull campaigns and bull auction sales were other methods given prominence. Catawba and Gaston Counties, N. C., completed the eradication of all grade and scrub dairy bulls. In Gaston County handbills advertising the fact were posted on highways.

Progress was made in the South by dairy-herd improvement associations. The elimination of poor cows, improvement of feeding methods, and other means of herd improvement were practiced by these cooperative organizations of dairymen. As systematic records were kept by most of the associations, a specific measure of results was afforded. In 11 Southern States, there were 80 associations representing 1,460 herds and 35,942 cows. Seven associations in Texas are not included in the 80 associations mentioned as complete data regarding cows and herds were not available.

More than 32,000 demonstrations in dairying were carried on in the United States during the year, and 4-H club members completed 37,218 dairy projects. Extension workers assisted 19,729 farmers to obtain purebred sires and 23,108 to obtain high-grade or purebred females. Herds were culled by 15,420 farmers with the advice of extension agents; better-balanced rations were fed by 76,640 farmers; and 255,437 farmers had their animals tested for tuberculosis in campaigns in which extension agents participated. Better practices in dairying were adopted by 488,808 farmers, an increase of almost 27,000 over the previous year.

Better breeding received much attention. In addition to the regular extension work on this phase such as cooperative bull associations and sire campaigns, a newer specialized method that offered real promise was the proved-sire programs which were closely allied with the testing done by the dairy herd-improvement associations.

POULTRY

Poultry producers had a favorable year in 1929. Baby chicks were in demand and brought good prices due to the fact that flush spring production started relatively late. Throughout the spring storage season, with egg consumption at a high level, a favorable price was maintained. The late crop of pullets caused a favorable price level in eggs to be maintained during the fall and winter months. Farmers who followed the recommendation of extension poultry men to emphasize the system of flock management whereby the pullets come into production in the early fall months had very satisfactory financial results.

Poultry specialists brought out markedly in conference during the year the use of economic material and the need for more basic information in regard to poultry-industry and poultry-production costs. Census material, rural statistics such as county assessors' reports, and demonstration farm-flock records were given more attention. The number of States carrying demonstration farm-flock extension projects increased. Specialists obtained useful material from the data gathered, and the flock owner became more efficient as a result of this study.

One of the major activities of the county extension workers and State specialists in past years has been to emphasize the culling or elimination of low-producing hens. The extension organization introduced this feature of the work, which was carried on in 1929 in a large number of the important poultry-producing States by the flock-improvement associations. The activities of these associations were usually connected with the hatchery industry, but many of the free demonstrations formerly given by extension workers were supplanted by culling work on a self-supporting basis.

The establishment of service men by commercial interests was another trend in poultry-extension work. Only in 1928 and 1929, however, did such organizations as produce houses, hatcheries, and commercial feed concerns turn their attention generally toward this phase of education, although in some sections of the country, particularly California, the service man has been an institution for a number of years. Service and promotion departments were established by a large number of such establishments. Practically all of these service men, many of whom were recruited from the extension service, worked in harmony with the county and State organizations. They constantly turned to the United States Department of Agriculture and the State agricultural colleges for information on poultry. Although the motives of the commercial organizations were not purely educational, much advantage was gained by a proper coordination of the subject matter which they recommended.

In regard to national contests especially, the 4-H poultry club work took definite steps forward in 1929. A demonstration-team contest was established at the National Dairy and Poultry Show in St. Louis, and a 4-H club poultry-judging contest was established in connection with the International Livestock Exposition in Chicago. In time poultry-club shows may be developed, but no attempt was made at either of these two places to hold such a show. The Eastern States poultry show and judging contest held in connection with the Madison Square Garden Poultry Show in New York City was continued.

Disease prevention was one of the serious problems in poultry production. This problem was attacked in a number of States under the heading of chick-sanitation campaigns. Various slogans such as "Grow healthy chicks," "Produce paying pullets," and "Wage war on worms," were used in these educational campaigns, but all the campaigns had the same fundamental principle of showing prevention rather than cure. The State extension workers organized the programs, which in some instances were carried to every county in the State. The development of a variety of means and agencies to reach a large number of poultry raisers was one outstanding feature in the campaigns. Much was done by a sanitation committee composed of representatives from 14 national poultry organizations to promote poultry sanitation. This committee held two sessions. The subject of disease prevention was to be given special emphasis by this committee, which planned to meet from time to time.

Extension workers taught 70,062 farm men and women to cull poultry, 90,683 to feed better-balanced rations, and 72,693 to control insect pests. On 32,575 farms poultry raisers were induced to obtain purebred cockerels, 21,358 were assisted in obtaining purebred fe-

males, and 2,820 were influenced to have their birds tested for tuberculosis. Demonstrations in poultry production were conducted by adults on 62,214 farms, and junior 4-H club members completed 60,020 demonstrations. More than 318,553 farms were reported as accepting and using the poultry practices recommended by extension workers.

AGRICULTURAL ENGINEERING

The control of soil erosion continued to be the principal agricultural-engineering activity during 1929. Publicity campaigns proved effective in calling the attention of landowners to the serious losses from soil erosion and in creating interest in the methods of control recommended by the extension specialists.

During the year terraces and soil-saving dams were constructed on 61,198 farms where they served to prevent erosion on 1,819,282 acres at an average cost of from \$5 to \$10 per acre. Because only comparatively few farmers were properly trained to locate and construct terrace systems the amount of work accomplished was limited. The extension specialists in several of the States attempted to overcome this difficulty by holding 2-day terracing schools at which farmers were given detailed instructions relative to the laying out and construction of terraces. These schools were well attended and materially increased the number of men trained to do terracing work in the States in which the schools were held.

More than 131,000 acres of cultivated land, on 18,116 farms were cleared of stumps and stones. No attempt was made to clear new land, but attention was devoted rather to clearing up existing fields so that it would be possible to use modern farm machinery to advantage.

Drainage improvements were made by 13,803 farmers, more than 346,000 acres being drained by open ditches and 65,000 acres by tile. To improve more than 72,000 acres on 1,805 farms, irrigation systems were installed.

Many farmers began to use modern farm machinery and equipment in an effort to lower the cost of production. As a result of numerous meetings held by extension agents to demonstrate the proper use of the latest types of plows, planters, cultivators, harvesters, tractors, silage cutters, and seed cleaners, 24,167 farmers purchased machinery of a better type and 11,604 additional farmers followed suggestions on the maintenance and repair of machinery.

Extension agents reported that 3,055 new dwellings were constructed and 3,827 old dwellings were remodeled according to plans furnished by extension engineering specialists, and that 4,534 sewage systems, 3,927 water systems, 747 heating systems, and 3,451 lighting systems were installed according to recommendations.

FARM MANAGEMENT

The demand from farmers for economic facts for use in their farm-business planning showed a continued increase, as indicated in reports of the farm-management work done by the cooperative extension service in the different States. The program designed to assist farmers in this very difficult problem of adjusting their production to the probable needs of the market was approached in two

ways: (1) Through the dissemination of the present available facts bearing upon the future economic conditions of the important farm products; and (2) by assisting individual farmers and groups of farmers to adjust their farming operations to the conditions that are likely to confront them.

The State extension economists accomplished much in the assembling and preparation of economic subject matter for extension uses. Preparation of outlook and related facts in strictly popular form for general distribution to farmers was emphasized. As the demand for economic information was for facts as well as conclusions drawn from them, this procedure was found to be one of the first requirements in presenting an analysis of the situation upon which the farmer could safely act.

Effort was directed toward and through five main activities in order to meet the needs of farmers as adequately as possible.

(1) The teaching of the application of good farm-management principles and the economic background of the factors influencing commodity price changes.

(2) The dissemination of timely information in *The Agricultural Situation* and *The Agricultural Outlook*, including facts regarding crop acreages, conditions, and probable production; economic changes in the livestock industry; interpretation of trends in production and consumption; and prospects for the future.

(3) Facts that assist the farmer to understand the types of farming areas and what constitutes good farm organization and enterprise management within these areas.

(4) The development of a farm-accounting service that would enable the farmer to set down the essential facts that are necessary for him to have available in thinking his problems through clearly and accurately as a basis for improvement. More than 30 States have developed a system of accounting sufficiently simple to require a minimum of the farmer's time and yet sufficiently complete in facts to enable him to make an accurate and thorough analysis of his individual business.

(5) Assistance in building extension programs. The program-building work opened the way to clearer cooperation between different extension specialists, leading farmers, and others in coordinating economic and production facts in all extension work.

In 1929 extension agents in 1,206 counties reported assisting 25,402 farmers in keeping farm accounts, and in 904 counties extension agents assisted 20,210 farmers in keeping cost-of-production records. The assistance given by county agents to farmers in adjusting their operations was not, of course, limited to those who cooperated with them in keeping accounts.

In 1929 organized farm-management extension programs were conducted in 31 States, with one or more men devoting full time to the project. County agents in 1,655 counties reported that 88,503 farmers put into practice one or more of the better farm-management methods taught by extension agents. Agents also reported that 25,402 farmers kept farm-account books: 20,710 were assisted in keeping cost-of-production records; 12,801 were advised concerning leases; 22,131 adopted the cropping, livestock, or complete farming

systems recommended; and 10,747 made changes in their farm businesses upon the advice of the agent. Boys' and girls' club members also completed 7,379 farm-management extension projects.

COOPERATIVE MARKETING

Increased effort was expended in many States in 1929 in an attempt to add to the membership of existing farmers' cooperative-marketing organizations, thereby enlarging their volume of business and creating more economical units for operating purposes. The creameries and milk-receiving stations which had been operating on too small a volume to be profitable combined to form larger and more profitable operating units. In at least five States the livestock-shipping-association territory was surveyed with a view to combining several local associations into one large efficient organization. The trend toward the merging of small operating units into larger units with more volume and consequently more bargaining power was rather general throughout all commodity groups. The passage of the agricultural marketing act establishing the Federal Farm Board undoubtedly had an important influence on local movements, most of which had as their definite goal affiliation with national commodity organizations.

Perhaps in no previous year has there been such a marked trend toward more rigid standardization of all agricultural products in order that they may more nearly comply with the United States standard grades and thereby reach the ultimate market with the least possible culling loss and give the highest net sales returns to the producer.

During the year cooperative-marketing schools, lasting from one to three days, were conducted in several States in cooperation with the United States Department of Agriculture, agricultural colleges, and marketing and other farm organizations. The average attendance, consisting largely of officers and directors of cooperative-marketing associations and other leaders of the cooperative-marketing movement, was well over 200.

Extension workers disseminated market information to an increased number of farm families through the radio market-news service, by means of which market commodity reports are received and distributed from leased-wire stations, carrying the market deliveries, market movements, market stocks on hand, price trends, and prices paid on the day's market. Such information tends to make it possible for the farmer to obtain the highest possible net returns for his products.

Assistance was given by extension workers in the organization of 1,089 new farmers' cooperative-marketing associations during 1929. Extension agents also helped to solve the marketing problems of 2,809 cooperative associations that had been previously organized. A total of 581,389 farmers, adopted improved marketing practices as a result of extension activities during the year. The volume of business carried on by all cooperative-marketing associations organized with the aid of extension agents was valued at \$274,704,405, of which \$21,313,740 was the estimated profit from sales or savings realized from cooperative purchases.

FOODS AND NUTRITION

An increase of 243 home demonstration agents in 1929 made possible better organization and supervision in the foods project in a number of counties, a situation which was reflected in greater enthusiasm on the part of the women, a larger percentage of completions, and more exact records of results than were possible in counties that did not have home demonstration agents. Nutrition specialists gave considerable time during the year to training new home demonstration agents to present or supervise the foods and nutrition project.

The problems encountered in this project are of deep-seated origin and will continue for years to come. Although they differ in number and intensity in different localities, these problems are fairly characteristic of rural homes the country over. Many of them are equally true of urban homes. They may be roughly analyzed as follows:

In many homes bad cooking methods exaggerate the situation resulting from poor food selection by reducing or impairing the mineral and vitamin content of the foods prepared for the table or making them unpalatable. The untrained cook frequently renders good foods unwholesome as well as flavorless.

On some farms the food supply does not provide enough of the essential foods to meet the family's nutritional needs throughout the year. Farm people readily admit that shortage of vegetables is too often not made up by cash purchases. Long-distance shopping is inconvenient and the cash income for the average farm is low, ranging from \$500 to \$1,000. Since the minimum cost of the staple dry groceries needed for a family of two adults and three children has been estimated at not less than \$250 a year, it is plain that after the other necessities of the budget are provided for there will be little ready money to spend for fresh vegetables and fruits. Lack of acquaintance with grades and standards often results in uneconomical expenditure of the money available for food.

Faulty food habits and inadequate food supply may, however, arise from causes quite apart from ignorance of nutritional needs and difficult growing conditions. The home maker may find her efforts to provide a better-balanced diet checkmated by long-standing food likes and dislikes of members of the household, who may even take a perverse satisfaction in resisting changes. Some women seem to lack the wisdom, tact, and perseverance to cope with a family situation of this type, for which they themselves may unwittingly have laid the foundation.

A clearer realization of these problems has led to the formulation of somewhat the following methods of work in a majority of States: An introductory or foundation series of from four to eight meetings is held with home demonstration clubs or special project groups, in which the internal and external signs of good health, the food needs of the body, and the outstanding values of common foods are presented. The food-selection score card is used to check present food habits and to measure improvement made. Food preparation is usually an important part of this project, because it dramatizes the work, sets standards of food preparation, interests the women, and helps them to get their families out of food-habit ruts.

Another series may be devoted to the general problems of meal planning and serving, sometimes including work on food buying. The feeding of expectant mothers, infants, and children of preschool and school age is often organized in a separate series of meetings, especially where groups consisting largely of mothers can be brought together.

The home maker must not only consider the food needs of the normal members of the family but, with the advice of her doctor, she must plan and prepare the diet for the ailing. Small wonder that there is a call from many groups for information on how the body digests and assimilates its foods in normal health and in such conditions as constipation, diabetes, kidney trouble, indigestion, and cases of decided overweight and underweight. Although extension workers do not usurp the province of the doctor in diagnosing individual cases and prescribing individual diets, they have helped many a perplexed home maker to carry out directions intelligently, and thus to relieve or cure serious conditions arising mainly from lack of proper feeding. This type of work usually is reserved for a second or third series of meetings, after the women have mastered the general foundations of food selection for normal adults and children.

Work with 4-H club members constituted an increasingly important part of the extension program in foods and nutrition. In 1929 there was a marked increase in the number of clubs organized for some phase of the project, in total enrollment, and in interest. 4-H clubs for girls were carried on in canning and food preservation, bread making, baking (other than bread making), food preparation, meal planning and preparation, food for health, hot school lunch, and mothers' vacation clubs.

Throughout almost every outline for foods-club work for girls ran the fundamental aim of improving health through attention to good food habits and the skillful preparation of essential foods. Several States made the improvement of health through good food selection the main objective of certain clubs. Working toward the health contest as a climax, and assisted by physical examinations in the local clubs, 4-H club girls developed great interest in checking and improving their own food and health habits and bringing themselves nearer to the standard of good health and nutrition. The more advanced groups often selected younger members of the family or a younger class in school, with whom to conduct feeding and health demonstrations. Practically all of the advanced canning clubs required their members to make a food-preservation budget to meet the needs of the family. This requirement doubtless was stimulated by competitive exhibits featuring the canning budget at the National Club Congress and at State and county fairs.

The questions of farm income, of adequate standards of living for the farm home, and of the buying power of the farmer's dollar engaged the attention of groups of local men and women under the leadership of county, State, and national extension workers in numerous counties during 1929. These economic conferences, based on data collected by extension workers from statistical sources and on surveys taken by men and women leaders, of local conditions and of local habits and attitudes, revealed many problems in foods and

nutrition. In one type of conference, committees of local people estimated the expenditures for food, clothing, and household furnishings, which should be included each year in the farm family budget to provide for a reasonable standard of living, and then made these estimates the basis for determining the size and organization of the farm necessary to provide a sufficient income under local conditions.

Nearly all these conferences finally set up standards for a milk supply; a food, garden, and canning budget; and the number of meat animals and poultry to be raised and slaughtered for home consumption. What was more to the point, both men and women delegates undertook to forward a community program formulated by the conference. Economic conferences were held in 1929 in Arkansas, Colorado, Idaho, Illinois, Montana, Nevada, North Dakota, Oklahoma, Oregon, South Dakota, Tennessee, Utah, Vermont, Washington, West Virginia, and Wyoming. The economic approach not only reenforced the food-production program, but emphasized the necessity of this work for health and for economy.

The year was marked by a determined effort to make contacts with a larger number of homes and to influence practices even of persons not connected with organized project groups. In addition to encouraging the efforts of enrolled group members to pass on information regularly to their neighbors, agents spent much time in organized information work. Compiling mailing lists of persons with special interests—for example, mothers of younger children; writing circular letters, many of them attractively illustrated; preparing general and feature articles for the county and State newspapers and for State extension publications claimed the attention of specialists and home demonstration agents. Specialists reached large audiences through radio talks. More attention was given to general meetings in the county as an introduction to, or as follow-up of the work of an organized project group. Lantern-slide series furnished by the Federal office or developed by the State, motion pictures, and other devices lent interest to these meetings.

Achievement days continued to furnish a climax for the work of the project group and to serve as an opportunity for discussion not only of accomplishments, but also of problems uncovered by a study of conditions and of plans for meeting these problems by continued work. Observance of achievement days for the garden and nutrition projects usually took the form of tours to visit, especially fine gardens or well-stocked storage cellars. Window displays were more widely used than in previous years. For example, in connection with its child-feeding project, Kansas developed a standard plan for an exhibit of calcium-rich foods, showing the kind of each food required to furnish enough calcium to build a child's tooth. These exhibits were so arranged that they could be set up in different places over the county by local leaders and local grocerymen.

Nutrition specialists from 9 of the 11 Western States met at Las Cruces, N. Mex., in November to review the progress made on the Western States program since 1924 and to lay plans for future work. Nutrition specialists from Texas attended this conference as visitors. The specialists of the Northeastern States gave considerable time during 1929 to the preparation of economic data to be discussed at the conference of nutrition specialists planned for this region in 1930.

There were 46,673 demonstrations in nutrition conducted by rural women and 65,652 by 4-H club members. As a result of these demonstrations and supplementary methods designed to widen their sphere of influence, 72,816 women balanced their family meals according to approved methods, 39,376 women prepared better school lunches, 2,677 schools were induced to serve a hot dish or school lunch at noon, and 36,442 home makers adopted better practices in child feeding. A total of 206,243 home makers improved nutrition practices during the year.

Bread-making habits were improved for the first time under the direction of extension workers by 61,056 farm women; 67,591 adopted better practices in cooking meats; 106,271 in cooking vegetables; and 71,482 in preparing dishes made from dairy products. The family food supply was budgeted for the first time by 23,112 women, and 109,409 improved their practices of preparing meals. Altogether, there were 279,747 home makers who were reported as having adopted at least one of the better practices of food preparation taught by the extension agents.

In food preservation, 101,199 women were reported as adopting improved practices in preserving fruits and vegetables and 34,583 in preserving meats and fish. The amount of food products preserved by these women consisted of 21,386,699 quarts of food canned, 1,566,412 pounds of fruits and vegetables dried, and 12,409,885 pounds of meats cured. Better food-storage facilities were provided by 21,761 homes. In all, 171,037 homes were reported as having adopted improved practices in food preservation.

CLOTHING

Clothing work continued to be popular among farm women and girls during the year, construction, selection, and renovation being emphasized. Increased attention was given to the selection of comfortable shoes and hosiery.

To teach the importance of color, line, design, and tastefulness in clothing, fashion shows were held in several States. Children's garments showing good design, trimmings, and combinations of materials and colors were exhibited in many communities.

The discussion of color in the clothing work helped farm women to realize the need for beauty in the home. Points in the selection, construction, and care of linens and other textiles for household purposes were taught.

With the assistance of extension workers 392,414 home makers accepted the demonstrated clothing methods, among which were the selection of clothing with reference to attractiveness, suitability to the wearer, health, and economy; time-saving practices in garment construction; use and alteration for personal requirements of commercial patterns; the keeping of clothing accounts and budgets; selection of dress goods; principles of designing and sewing; use and repair of the sewing machine and its attachments; planning layettes; and repair and care of furs.

During the year farm women carried on 84,217 demonstrations in the various phases of clothing activities, and 4-H club girls completed 190,249 demonstrations. Improved practices in the selec-

tion and construction of clothing were adopted by 144,589 women; in renovation and remodeling, by 75,527 women; in millinery, by 97,377 women; in costume designing, by 64,492 women; in children's wardrobe planning, by 40,619 women; and in infants' wardrobe planning, by 19,146 women.

HOME MANAGEMENT

In the development of home-management extension programs for 1929 the problems dealing with economics of time and money were taken into consideration. Those mentioned most often in home-management reports were: The scarcity of ready money, absorption of farm profits by purchase of farm equipment and additional land, use of ready cash in purchase of automobiles and gasoline, occupancy by farm families of tenant homes or poorly planned houses, lack of electricity for power and light, distance from buying centers, and satisfaction of farm families with present conditions.

The number of home-management specialists employed to develop the home-management project showed the growing interest by rural home makers in this study. Home-management specialists were employed in 34 States; in other States the work was done by the State leader or assistant. A trend toward the study of the home maker herself and the ways in which she may better fit herself to handle her home problems dealing with the economic and social aspects of everyday living, and a trend away from the study of the kitchen and its equipment were shown in 1929.

Rural electrification made progress. The factors to be considered in the purchase of electrical equipment, how to use electricity wisely, and the upkeep and repair of electrical equipment were discussed by groups of rural women.

Rural women as well as men throughout the United States became more thoroughly interested in the economic aspects of the farm home through the work of the Federal Farm Board. As the result of economic conferences on the farm home, rural women set up recommendations on the minimum cash income for a family of five. The budgets so far set up for a farm family of five show the following average: Food, \$340; clothing, \$360; health, \$80; operating expenses, \$140; additions and replacements, \$105; education, \$140; personal expenses, \$75; and church and charity, \$75; a total of \$1,315.

The farm and home-management programs were brought closer together through economic conferences. As the result of an analysis made by the women, showing that it is impossible to live adequately on less than \$1,200, farm men and women in States where economic conferences were held set out to find ways and means of increasing the cash income of the farm.

As a result of this work rural women appreciated the fact that very often they do not know where the money comes from or where it is going. After the economic farm-home conferences had been held, follow-up work was done on household account keeping and "buymanship." During 1929, 10,591 women made budgets and kept accounts.

Very few facts were found available upon which extension agents could base home-management programs; local home demonstration

councils gave assistance in this work. Important facts were brought out by surveys on the particular problems in which the farm women were interested. These sometimes caused a change in the extension program.

Two hundred and forty-four homes in Nebraska showed, as the result of a survey of laundry conditions, that 24 per cent of the women washed in the kitchen, 14 per cent used the basement or separate washhouse, and 47 per cent used porch or shed room. The laundry equipment on hand showed a range in price from \$12 to \$375. Doing the family laundry at home cost from 10 to 40 cents per washing. The average time used by women in washing was 36 minutes for preparation, 190 minutes for washing, 37.6 minutes for hanging and bringing in dry clothes; 138.1 minutes for sprinkling and ironing, and 21.9 minutes for cleaning up equipment, a total of 7 hours and 3.6 minutes to wash for a family of 4.7 people.

Surveys to obtain information upon which to base the home-management program, the training of local leaders to pass the information on to others, circular letters, newspaper publicity, radio talks, demonstration homes, tours, exhibits, demonstration trucks, scoring, demonstration kits, slides, charts, and posters were the measures used in 1929 more than ever before by home-management extension specialists.

Many tours were conducted to homes in which demonstration kitchens were established. The demonstration kitchen continued to be reported as one of the best methods of obtaining results in home-management project work.

One woman discovered that she could save 15 minutes a day in washing her separator if she moved her dish pan to a more convenient position. Another, who made a study of lamp cleaning, saved 30 minutes by having members of the family bring down lamps in the morning and return them at night, and by improved methods of cleaning. Another woman told how a dish drainer saved her 30 minutes daily. Many States reported work on how to save time and steps in everyday housekeeping.

This type of work resulted in 21,038 women following a systematized plan of housework, and 28,733 planning or rearranging their kitchens for convenience during 1929.

Many human-interest stories of equipment installed and farm homes made efficient and attractive with little cost were told by extension agents and women. A typical story was related by a farm woman in Kentucky. This reads as follows:

We had been interested in putting water into the house for quite a while, but the kind of system we were thinking of cost several hundred dollars, including the digging of a deep well (we have only a cistern), so we never got around to it. But after seeing the illustrations of these simple systems, we had a pitcher pump, sink, and drain in less than a week, and my husband did all the work. After knowing the convenience of this easily installed and cheap (cost less than \$10) way of having water in the kitchen, I feel like preaching to the farm women the "Gospel of the Kitchen Pump."

During 1929, 37,467 result demonstrations were conducted by extension agents; and 126,369 different homes adopted improved practices in home management.

HOUSE FURNISHINGS

Some of the aims of extension workers for home improvement are: To create more useful and beautiful home interiors; to teach good design and wise selection of home furnishings; to create better family relationships through artistic, comfortable surroundings; and to create a home that will teach boys and girls good standards of living. Most of the States have long-time programs which aim to accomplish as much as possible each year.

The following topics were covered by subject-matter information given in the various States: Furniture arrangement; color and design; floor, wall, and woodwork finishes; home dyeing; homemade rugs; curtains and draperies; the selection of commercial floor coverings; slip covers; the selection of household linens; refinishing and renovation of furniture; the wise choice of china, glass, and pottery; pictures for the home; basketry accessories; storage spaces in the living room and bedrooms; and lighting and lamps.

Once the farm family becomes interested in beautifying the interior of the home it soon asks for help in beautifying the exterior surroundings. Specialists in landscaping and forestry cooperated with specialists in home furnishing and home management to develop this phase of the work. The reports showed that 112,533 home grounds were beautified.

The demonstration home, used in extension work in 1929, was considered one of the best means of carrying the message of beautification of the interior and exterior of the home. Publicity was given to the results achieved by means of tours; achievement day programs, where plays and skits on home-furnishing topics were given by the women; and exhibits.

The girls' 4-H club work in room improvement continued to grow.

In the United States 92,095 women reported adopting improved practices in selection and arrangement of furnishings; 56,345 women and 22,849 girls repaired and remodeled furnishings and thus put into practice the slogan, "Make the best use of materials on hand"; floors, walls, and woodwork were improved by 52,094 women and 20,991 girls. Girls and women worked on 57,120 bedrooms, 34,279 living rooms, 20,207 dining rooms, and 27,119 other rooms.

Home-furnishing work was very popular during 1929 as was shown by the fact that 167,028 women adopted improved practices in comparison with 141,034 during 1928.

HOME HEALTH AND SANITATION

Correlated closely with activities in home health and sanitation were those in home improvement, home management, home equipment, clothing, and especially in nutrition. Local physicians, dentists, and nurses cooperated with extension agents in convincing farming people that the conservation of health is important, and gave special attention to the care of teeth, eyes, and ears; personal cleanliness; good posture; healthful food; proper recreation; prevention of colds; and sufficient sleep. Home nursing, first-aid treatment, invalid diet, and similar measures were encouraged by extension workers in cooperation with health agencies and welfare workers.

Proper sanitation was emphasized by advocating such measures as good ventilation; screening to keep out flies, mosquitoes, and other insects; eradication of rats and ants; use of pure drinking water; introduction of adequate provisions for bathing; clean-up of the farm premises and outlying dump heaps; and the sanitary disposal of garbage, trash, and sewage.

In the various phases of health and sanitation 4-H club members completed 77,932 demonstrations, and adults carried on 27,847 such demonstrations during 1929. The recommended health practices were adopted in 101,137 homes; in 6,140 homes sanitary closets or outhouses were installed; screens were placed in 9,459 homes; and other methods of controlling flies, mosquitoes, and other insects were followed in 17,086 homes. Improved health and sanitation practices were adopted in 76,028 homes.

EASTERN STATES

The Eastern States, one of the four divisions into which the administrative work of the Office of Cooperative Extension Work is divided, includes Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, and West Virginia. Florence E. Ward continued as regional agent representing the office in its cooperative relations with these States.

Farm-management studies in New York State point out the problem of the adaptability of certain crops to the local soil types. These studies show that apple growing in certain areas will never be profitable because of unsuitable soil types. They show that the abandoned farms or the submarginal farms are also tied up with the soil problem. It is claimed that of the 5,000,000 acres of farm land abandoned in New York since 1881, at least 4,500,000 should remain in forest or be reforested. Surveys show that the total gross incomes on poor-soil types, as in the Connecticut hill areas, average only \$400 per farm. In New York the extension agents are discouraging farmers from continuing to grow potatoes on heavy soils and land infested with wireworms. The heavy soils have been used for many years to grow timothy and grain, but since these crops are no longer profitable the problem is what to do with them.

In some areas of the East the farmers have more timothy hay than they know what to do with. Where some of the timothy-hay land can profitably be turned into alfalfa or clover pasture, summer feed for dairy cows is provided. Most of the States are making good gains in alfalfa and clover acreage, New York leading with about 20,000 acres of new seeding each year. The high cost of lime and the unsuitableness of some land make the problem a difficult one in many areas; however, dairying and farm-management specialists are urging farmers to cut the timothy earlier (thus getting better quality) and to develop supplementary feeds that will make the most of the timothy hay where alfalfa can not be grown.

Pennsylvania has led during recent years in showing farmers what can be done toward making potatoes a very profitable farm enterprise through planting larger farm acreages and intensive programs of spraying, disease control, and the best cultural practices.

Last year New York made a definite start to regain her market for potatoes by organizing a better potato campaign in three counties. Maine is still intensifying on the use of improved seed, seed treatment, and better harvesting; all contributing to maintaining and improving the quality of Maine potatoes. Two hundred and fifteen demonstrations in improved seeds were conducted in 12 counties. In Aroostook County 416 cooperators reported the use of padded diggers on 18,128 acres in order to reduce the amount of bruising and cutting of market potatoes.

The New England States have united and agreed on the New England Seven as seven standard varieties of apples to recommend for planting and topworking. In 1928 these States united in a drive to get fruit men to top-work undesirable trees to these seven varieties. In 1929 the emphasis was placed upon control of insects and diseases through correct spraying. This feature was marked by 90 per cent apple clubs in some States, meaning a goal of 90 per cent of the apples free from insect or disease blemish. This uniting of six States in a regional program is noteworthy.

Of outstanding worth is the new work in Massachusetts and New Jersey in teaching market gardeners the sensitivity of vegetables to acid soils, and the teaching of liming the soil and the planning of rotation and companion cropping to avoid following acid-tolerant crops with nontolerant crops. At Concord, Mass., the truck farms were white with lime the past year as a result of this effort.

In New Jersey the vegetable-gardening specialist has for two years concentrated on getting the many tomato growers of the State to plant earlier and to use stocky home-grown plants. "Early planting brings the tons" was the slogan. Plants set out May 5 to 15 consistently show increases of from 2 to 4 tons per acre over those planted June 1 and later.

Pennsylvania is showing how good planning and effective teaching methods may influence people to adopt practices in wood-lot management and in planting idle farm land to forest trees. Berks County has carried on the wood-lot management project for four years with from 90 to 125 cooperators every year, Columbia County has 250 cooperators this year. Equally good work is being done in farm-forest planting in New York.

Outstanding in the dairy work are (1) the increase in the number of herd-improvement associations, (2) the development of modified associations of this kind, and (3) adjusting milk production to demand. In Orange County, N. Y., 100 dairymen with 2,000 cows signed up in the modified association, or dairy record club, and paid in advance. This association follows the Wisconsin type, with improvements in equipment and management. An assistant county agent is in full charge, and additional help is available for testing and computing. Three adjoining counties are also mailing samples to this laboratory for testing. In seven other counties the dairymen deliver their samples to local milk-receiving plants, and records are figured in the county agent's office. Costs vary from \$1.20 to \$1.80 per cow per year. Pennsylvania also has a well-organized and working cow-testing association of this modified type.

On account of the fall shortage of milk in New York City and other large metropolitan areas, extension workers, representatives of

the fluid-milk distributing agencies, farm management and marketing specialists worked together in determining a program that would result in more closely fitting production to demand. New York and Vermont, serving the New York City and Boston areas, worked hardest in this, organizing well-planned campaigns to get farmers to change feeding and management of their herds so that more milk would be produced in the fall months. The campaigns were eminently successful; for this work, coupled with a favorable late-pasturage season and some other factors, actually developed a fall surplus which alarmed some dairymen and distributors. However, it has been stated by responsible extension and farm-economics people that this surplus was more apparent than real and that great good was accomplished by the campaign.

The Eastern States have led the country in showing poultrymen how to control disease and parasites through "Grow healthy chicks" campaigns and the like. Thus cooperators in Connecticut have cut their losses down to an average of less than 7 per cent of their chicks, and the home egg-laying-contest records show that the hens produced from these healthy chicks have increased their egg production to an average of 160 eggs per hen, a 20-egg increase.

For the most part, home demonstration work in this area is organized around community groups. In many cases farm women to whom extension teaching would be most valuable are unable to leave home to attend group meetings. Each year an increasing effort is made to reach these women by the use of newspaper stories and circular letters. Many other women have not been interested in attending meetings, but their enthusiasm is aroused through a contest, a tour, or a fashion show; they are influenced through these channels to make changes in their kitchens and in selecting their food and clothing.

The expression "square meals for health" is becoming a familiar one in Maine to men, women, and children. Carried as a contest for three years in connection with the community meal project, "square meals for health" are now features of meetings of many rural and town organizations.

In Connecticut, as a forerunner to launching a clothing project, fashion and fabric shows have been held in several counties. These are sponsored by the local chamber of commerce and as many department stores as wish to cooperate in lending garments to be worn by models. The models are rural women, chosen to illustrate different types of figures. Children take part also, illustrating different age groups, such as preschool, grade, high school, and college.

As the show progresses, the clothing specialist tells the audience as each model appears what points were considered in selecting the garment for this individual. This is proving an effective way to teach selection of clothing, emphasizing suitability of garment to wearer, and taking into consideration line, design, and color. Hats, shoes, and accessories all come in for their share of attention and interest. Last year 9 shows of this kind were put on in 6 counties with an attendance of 2,975 people.

Farm-bureau women in Berkeley County, W. Va., were indifferent to a nutrition program. In order to determine the need, the home

demonstration agent obtained figures from the health department. These figures showed that 25 per cent of the school children in the county were seriously underweight, while practically half of them had a cavity in at least one tooth. The agent next visited the schools, scoring more than 2,000 boys and girls on their food habits. The average score was 60 per cent, the chief errors being lack of milk and vegetables with many sweets between meals. A poster contest was conducted and 1,000 posters were made, bringing out the idea of food for health. The home demonstration agent then appeared before the farm-women's bureau, stating the facts and figures and asking each unit to elect two representatives to act as speakers at programs in each school centered on food for health. This proved to be an effective means for reaching parents and also an effective means of convincing the farm-bureau members of the need for better nutrition in Berkeley County. As a result, each of the six clubs has elected a full year's nutrition program for 1930. The members themselves have taken an active part in planning this program which is based on their problems as they see them. For instance, the theme of the first meeting is "how to overcome food prejudices among members of the family."

In Franklin County, Vt., a farm and home-economic conference was held in December, 1929. This was the result of preparation for many months, during which time surveys were made to determine farm-home conditions, size and type of farms, and income from farming. In the surveys which concerned the farm home, local leaders were trained to secure the information. Four training schools were held for leaders along the following lines: Foods, clothing, home furnishings, farm-home conditions, including the budget. At the conference, 150 farm men and women came together for two days to discuss the findings revealed by these surveys. From figures available the average amount for family living in farm homes in this county is \$825 a year. Working in committees, guided by extension specialists and agents, these representative farmers and home makers set up living standards for farm families in their counties. They made recommendations for size and type of farming business to produce the \$1,500 net income which farm women named as the cost for a minimum standard. Out of these recommendations will evolve a long-time farm and home program in Franklin County. The home demonstration agent spent in all 30 days in preparation for the final conference. She stated that it was a most profitable expenditure of time as it gave her a grasp of the situation in her county such as she had not been able to get in any other way during her three years of service.

The goal set for the development of 4-H club work two years ago was that every agricultural county within the 5-year period would be served by a person devoting his full time to 4-H club work. At the present time New Hampshire, Massachusetts, Connecticut, Rhode Island, and Delaware have reached this goal, while Vermont, Maine, and New York are rapidly approaching it.

As evidence of the effectiveness of this method of doing club work the State leader in New York indicates in a 1929 narrative report that of the 20,000 club members in the State who were enrolled in 51 of the 55 agricultural counties, more than 85 per cent were in the 27 counties employing full-time county club agents.

Increasing cooperation with subject-matter specialists along various lines is evident, and there are at present 12 full-time specialists in agricultural and home-economics lines of subject matter who devote their entire time to 4-H club work. We may expect this tendency to grow somewhat in the larger States with an increase in the volume of work to be done and with an increase in the large job with which they are confronted in training volunteer leaders.

The enrollment in boys' and girls' clubs in the Eastern States constituted about 12 per cent of the total enrollment for the United States. The total enrollment of young people for the Eastern States this year is more than 92,000. The big gains to be made in club work in the Eastern States will come in Maryland, West Virginia, and Pennsylvania.

The review of the project activities in the Eastern States for 1929 shows little change over the previous year, although somewhat greater emphasis has been placed, and will continue to be placed, on making the club teaching program more specific and more adaptable to meeting the needs of those participating. More emphasis in the dairy States on the development of demonstrations and supplementary work having to do with the production of clean milk was noted. The first definite project along this line was conducted under E. S. Guthrie in New York State in 1927.

Interest increased in forestry work, and the new forestry specialist in the department, W. K. Williams, has been active in developing greater interest on the part of the State foresters in their work with farm boys. A recent report of forestry club work in New Jersey by E. L. Scovell, extension forester, presents a most interesting plan and point of view with regard to their forestry program in that State. In part, Mr. Scovell says:

Through our program for adults we are striving to change the attitudes of the present owners toward the farm wood lots and submarginal lands. In place of the present attitudes of indifference, partial interest, or opposition, we wish to develop an attitude of interest and understanding backed by the desire to do something with this property. Results are measured in acres of wood lots improved. Through our program for juniors we are striving to develop an attitude among our rural boys and girls which will assure the continual application of constructive-management practices on these properties; in this part of our program we measure results in terms of growth of the individual boy or girl—the extent to which each has acquired an increased interest in the woods, a stronger liking for them, a deeper appreciation of their value, and a greater knowledge of the principles of good wood-lot management.

The leadership-training program in the Eastern States this year continues to be one of the important parts of the county agent's job. This program is including not only the teaching of local leaders how to do specific tasks incident to their job, but it is also broadening into a phase of personal improvement and education for the leaders who participate. Local leaders were much interested in these programs, and increasingly they are determining the nature and content of what is offered.

The general policy with reference to club work in several States is to place as club agents men and women who are well trained and to give them budgets of sufficient size to provide the best possible material. The best exemplification of this policy is that of New York State. A minimum of \$2,500 is required to be raised within a county before the extension service will cooperate fully with

county funds. When the county raises this amount it will be supplemented by State and Federal funds so that the total minimum budget is \$4,700.

There is an increasing tendency to change the character of the State club camp or short course to make it a specific leadership-training course for older young people. The popularity of these events makes it necessary to decrease the number attending and to raise the lower age eligibility limit. In most States young people under 14 are not eligible to attend these club activities, and in one State definite plans are being made to have a separate camp for those club members 16 years of age and older, handling a larger group of younger club people the week following. The result of this increase in the age limit is tending to throw back upon the counties demands for more social activity such as county camps and field days.

CENTRAL STATES

The Central States consist of Illinois, Indiana, Iowa, Kansas, Kentucky, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, and Wisconsin. G. E. Farrell continued in charge of administrative contacts of the office with this group of States.

The year was one of steady progress in all lines of extension endeavor. Prominent among the developments noted during the year were the cordial relationship maintained with farmers' cooperative associations and organized groups of farm women, strong legislative support in several States for a program of financing county extension agents from public funds, increased interest in applying available economic information to farm adjustment, improvement in cooperation of extension workers and agricultural high-school teachers, and expansion of home demonstration work.

Agricultural outlook conferences were held in all of the Central States except Michigan. There has been a considerable increase during the year both in the interest among farm people in the forecasts and their confidence in outlook reports. Agricultural-adjustment conferences were held in Illinois for the second year. Program-building conferences were held in North Dakota counties during the year as a follow-up of the district economic conferences held in 1928.

This section of the office has laid special emphasis during the past five years on getting extension specialists, county agent supervisors, and agents to give more thought to the gathering of economic facts to be used in their projects. Most of the specialist plans of work for last year contained at least a page of such facts. County agents have been encouraged to look up more of the census facts and other statistics regarding the agriculture of their counties. Such material has been most carefully prepared in the Central States in which the most intensive county project plans or agricultural campaigns were developed.

The most highly developed farm-account work was done in Illinois. Outstanding farm-account work is also reported from Kansas, Minnesota, and Ohio. Enterprise cost records were carried on most successfully in Illinois and Ohio. Interesting studies of the farm-tax problem were made in Illinois.

The passage of the Federal agricultural marketing act had a tendency to slow up the cooperative-marketing work of the county agricultural agents until they could learn the program of the Federal Farm Board. The extension forces in each State stood in readiness to indorse and help advance the cooperative-marketing plans recommended by the Farm Board. Farm supplies were purchased cooperatively and most extensively through the cooperative elevators and farm bureau organized oil stations, many of which called upon county agents for information and advice. The most outstanding work in cooperative selling in which county agents have assisted has been the livestock shipping-association work, especially in Iowa, Ohio, Indiana, and Minnesota. The formation of marketing associations to handle specialized crops was promoted primarily in Missouri and Indiana.

The outstanding event in the Central States was the conference of the American Country Life Association held at Ames, Iowa. Through the efforts of the Iowa State Extension Service, a program was developed which was of sufficient interest to bring out for the first time during the history of the association a large attendance of farm people. The States doing outstanding work in rural sociology were Iowa, Missouri, Minnesota, and Ohio.

Erosion-control work was carried on most intensively in Missouri, Iowa, and Nebraska. The farm-machinery work of greatest interest was that done in relation to corn-borer control in Michigan and Ohio. Farm building plans were distributed mainly in relation to the building of hog and poultry houses and bull pens. Outstanding work along this line was done in Nebraska, Iowa, Illinois, Michigan, Minnesota, Kansas, Missouri, Ohio, and Kentucky.

In beef-cattle production the principal work has been done in 4-H calf club work and in the production of baby beef, especially in Iowa, Nebraska, and Minnesota. In dairying the greatest interest centered around the "short-cut methods" advocated primarily in Wisconsin, Minnesota, and North Dakota for getting a larger percentage of dairy farmers to keep herd records. Outstanding dairy-herd-improvement work was also done in Illinois, Iowa, and Michigan. The introduction of purebred sires has been emphasized the most in Missouri, Kentucky, Minnesota, Iowa, and Ohio. The principal dairy work in improvement of quality in production has been done in Iowa and Wisconsin.

Swine-sanitation work has been done most intensively in Illinois, Iowa, Minnesota, and Nebraska. Ton-litter contests have been featured again in Indiana and Minnesota.

Poultry-disease control and sanitation work have been done most successfully in Wisconsin, Iowa, Minnesota, and the Dakotas; poultry feeding in Wisconsin, Minnesota, and Illinois. Turkey production was stimulated through recommendations of the extension service and demonstrations relating to the raising of turkeys on clean ground. This work has been done most successfully in Minnesota, North Dakota, and South Dakota.

Multiple-hitch demonstrations have been conducted in nearly all of the Central States in cooperation with the Horse Association of America. This work has been most enthusiastically received by the farmers of the Dakotas, Nebraska, Kansas, Iowa, Illinois, Indiana, Minnesota, and Missouri.

County and community program building has been given special attention in Kentucky, Indiana, Wisconsin, Iowa, South Dakota, and Nebraska, while State program building has been considered primarily in North Dakota and Illinois. Program building around, and in cooperation with, commodity associations was continued in Michigan. The local leader or relay method of furthering agricultural projects has received special attention in Michigan, whereas the delegate-conference method has been used considerably in Missouri, Kansas, Nebraska, and Illinois. There was also a considerable increase in the use of county leader-training conferences to train local 4-H club leaders. Increased attention was given to strengthening the extension teaching methods used in most of the States.

The principal advances in county agent supervision have taken place in Iowa, Missouri, Minnesota, and Indiana. A complete analysis was made of agricultural extension work with the assistant directors and county agent supervisors in Iowa. There has been a considerable increase in the use of district conferences as a means of supervising county agricultural agents and also as a means of having various subject-matter specialists plan project work with the agents. Relatively definite supervisory programs were planned by the supervisors in all of the North Central States.

Special surveys or studies of the results of extension work were carried on in Kansas and Nebraska. Assistance was given by a representative of this section to supervisors and agents in planning agricultural campaigns in Missouri, Nebraska, South Dakota, Minnesota, Wisconsin, and Indiana. Assistance was also given in conducting the course in extension methods at the University of Wisconsin summer school. Special methods for improving circular letters of agents were used by the supervisors of county agents in Minnesota, Missouri, Nebraska, Iowa, Kansas, Indiana, and Wisconsin. Iowa conducted a state-wide conference at Ames of 84 county agent office secretaries to strengthen the office records and county agent office management.

Assistance was also given with reference to getting better photographs for use in extension work by representatives of this office in Wisconsin and Nebraska, and assistance in improving project exhibits was given to supervisors, specialists, and agents in Illinois, Iowa, Minnesota, Nebraska, Kansas, South Dakota, North Dakota, Wisconsin, Michigan, and Kentucky. Special assistance was given to the Nebraska Extension Service in planning and studying methods of improving a new type of county exhibits known as county resource exhibits. These were shown at the Omaha Ak-Sar-Ben Stock Show.

Corn-borer work was not stressed as much as in previous years, but there was some good work done in Ohio, Michigan, and Indiana.

The principal other insect-pest-control work has related to Hessian fly, chinch bugs, and grasshoppers. Spraying to control fruit and truck-crop insects was done most extensively in Michigan, Indiana, and Kansas.

Improvement of varieties and increasing legume acreage have received major emphasis in this project. The most successful legume work was in increasing the alfalfa acreage in Minnesota and Michigan, the soybean acreage in Indiana, and the acreage of sweet-clover for pasture in Wisconsin, Illinois, Minnesota, and Iowa.

Good organized work has been done in seed certification in every State except Kentucky. Among the States which have been the most active in bringing about the use of improved varieties are Michigan, Indiana, Minnesota, and Nebraska.

The planting of windbreaks and wood-lot management received major attention in forestry. These projects were carried on most successfully in Nebraska, Iowa, Minnesota, Wisconsin, and Michigan.

Extension work in fruit growing has centered around spraying and pruning with the most intensive work being done in Kansas, Missouri, and Michigan. Home-grounds-improvement work has been stressed in Nebraska, Iowa, Missouri, and Indiana. The testing of soils to determine their lime and phosphorus needs was done most successfully in Illinois and Indiana.

Considerable progress was made toward getting dairymen to eliminate cows infected with contagious abortion from the herds through the use of blood tests. The greatest amount of testing cows for tuberculosis was done in Wisconsin, Minnesota, and Illinois. Outstanding work in the control of poultry diseases was done in Minnesota and Illinois.

There was a revival of interest in weed control through the use of chemical sprays, especially calcium chlorates. Canada thistle and other weeds were killed successfully with these sprays on many farms in Illinois, Kansas, Iowa, Minnesota, Nebraska, and Indiana.

The end of 1929 finds a wholesome condition and outlook regarding home demonstration work in the Central States. Capper-Ketcham funds have served to focus attention on home demonstration work, which has expanded as a result. Sixty-six home demonstration agents were added during the fiscal year.

Improvements due to home demonstration work were reported by 633,760 women from 435,776 farm homes in the Central States. Volunteer service as local leaders was given by 36,938 women. Improvements due to home demonstration work were reported by 197,984 women outside the organized groups.

Two hundred and eleven home demonstration agents were employed in the 13 States during 1929. There were 95,749 women, or an average of 454 per home demonstration agent, who reported as members of organized groups from counties with home demonstration agents. These home demonstration agents also directed 4-H club work of 44,054 girls in their respective counties, an average of 208 per home demonstration agent. Of these 4-H club members, 33,230 completed their work in these counties.

During 1929, \$950,092 was spent for home demonstration and home economics specialist work in the Central States. This was an increase of \$169,873 over the previous year. The greatest increase was in Ohio, amounting to \$20,925. The total amount spent on home demonstration and home economics work represents 12.21 per cent of the total extension budget for the Central States. This amount compares with 20.82 per cent spent for home demonstration work throughout the United States.

Home demonstration leaders in the Central States indicate that in an increasing number of counties there is little difficulty in obtaining the appropriation for home demonstration work, and that the local women are assuming entire responsibility for presenting the budget to local appropriating bodies.

The development of local leadership continues to be the outstanding result of home demonstration work. The reports from the Central States indicate that 36,938 women served as local leaders. The development of county home committees is the most recent widespread development in local leadership, and it is having fundamental effect in vitalizing the home demonstration program, in obtaining local leaders, in setting up goals of achievement, in obtaining cooperation of local merchants, and in arousing interest among women in other parts of the county. Missouri reports 1,286 new leaders for 1929 who had not before served as leaders in any capacity.

Well-defined plans for supervision of county home demonstration agents and of home demonstration work in counties without home demonstration agents were prepared by the State home demonstration staffs in each State.

A general policy of a 1-day supervisory visit per month to each home demonstration agent is generally reported. District conferences of home demonstration agents and the annual extension conference are other times when supervision and training were given. Illinois held a 3-day training conference for all home demonstration agents who had entered the service during the year and who had been in their respective counties for several months. Ohio, Iowa, Kansas, Illinois, Michigan, Kentucky, and Missouri gave from one week to six weeks preliminary training in a home demonstration county before new home demonstration agents were given responsibility in a county.

State leaders in Ohio, Kentucky, and Missouri listed their supervisory accomplishments for 1929 and compared these with the goals set by them in plans of work made at the beginning of the year. Michigan home demonstration agents were helped to develop an inclusive rural home makers' list. This list was used as a basis for planning numerical goals in project work.

As home demonstration agents in the Central States increasingly assume responsibility for girls' club work in their counties, home demonstration leaders must give time to working jointly with the State club office in planning for wise consideration of the adult and junior needs and in working out a program which will render efficient service to women and girls without an undue teaching load or poorly balanced calendar of work for the home demonstration agent.

This same problem arises in relation to home economics specialists as they increasingly assume responsibility for subject matter for 4-H club work in home economics and as local leaders for 4-H club work are trained by these specialists.

During 1929, recognition of the necessity of ultimately having county home demonstration agents in all agricultural counties of the Central States was generally accepted by all members of the extension staff. Rural women are expressing their desire for this service and are willing to give much time and thought to it. On December 1, 1929, 17.5 per cent of the counties of the Central States had home demonstration agents.

In all Central States except Michigan (where county club agents are employed) home demonstration agents assume responsibility for the girls' club program. Approximately one-third of their time is devoted to the junior work, one-third to adult work, and one-third to general development.

During 1929, several Central States adopted the plan of having home demonstration agents in training to be ready for vacancies. Ohio reports, "The plan of keeping available several agents in training is to be continued," and Iowa reports, "We have been able this year to place some agents in training on a temporary basis. This is a great help." During 1929, Illinois had six agents at large.

A beginning in the development of long-time county programs is noted. Franklin County, Ohio, developed a clearly defined, long-time program in 1927, and in 1928 and 1929 programs were planned as short-time units of it. Kentucky and Illinois report 3-year programs. Iowa reports well-defined 3-year programs and that the home makers in some counties have definitely discussed a 16-year program of home-making project work.

Recreation was included as a part of the meeting for local leaders in nearly all home-demonstration-agent counties, the women carrying this plan back into their local meetings. In Kentucky district camps were held as a means of having training in recreation given to local leaders by a trained specialist in this field. Music was a well-defined project in eight States.

Civics, music, and reading are increasingly being included in community programs of work but they have not become major projects in any State.

During the past two years there has been a marked increase in requests for instruction regarding home furnishings and landscape gardening. This suggests an aroused consciousness among rural women of the need of beauty in the home. It is probable that the discussion of color in the clothing-project work has had much to do with this development.

The home-furnishings project has brought charm, comfort, and personal satisfaction to thousands of farm women and their families. The application of color to the beautification of a living room has been a matter of great interest, as has the information regarding window treatment, picture selection, framing and hanging, arrangement of furniture, floor coverings, and the selection and use of living-room accessories. Furniture renovation and repair was a phase of home-furnishings projects in several Central States. Handmade rag rugs served to improve the appearance of many homes.

Specialists and agents are recognizing that much attention must be given to the use of sound methods in training local leaders. The methods studied in 1927 have been definitely followed up in organized form by all counties having home demonstration agents in Ohio and Kentucky, and agents and specialists alike report great satisfaction with the results achieved. Kansas has followed up to a limited extent a similar study in foods and nutrition.

In every State concentrated effort was made to strengthen the quality and quantity of news regarding the program and results of home demonstration work. During 1929, 25,427 press articles were prepared by the 211 home demonstration agents who sent in statistical reports. This makes an average of 210 articles per home demonstration agent for the year. The total figure represents an increase of 7,284 articles over 1928.

The addition of 66 county home demonstration agents is the most concrete evidence of progress made in 1929 in the Central States.

The outlook is stimulating, and directors of extension and State home demonstration leaders report that a period of rapid expansion in home demonstration work is evident. It is probable that 30 to 40 home demonstration agents will be added during 1930.

During the year the supervision of boys' and girls' 4-H club work was carried on by 15 State club leaders, 49 assistant State or district leaders, 56 county club agents, and 7 assistant county club agents. This was an increase of 9 county club agents and 6 assistant county club agents over the number listed on November 30, 1928.

Total enrollment may be used as a measuring stick in 4-H club work. During the year, 254,764 different boys and girls were enrolled in 19,103 organized 4-H clubs in the Central States. This was an increase of 40,895 or 19.1 per cent over the 1928 enrollment of 213,869. The enrollment consisted of 100,185 boys and 154,579 girls. There was an increase of 15,026 boys and 25,869 girls. The total 1929 enrollment of 254,764 in the Central States comprised 33.7 per cent of the total club enrollment of 756,096 in the United States.

The rather concerted effort made in 1928 toward better county plans for 4-H club work was continued during 1929. There was a definite trend toward bringing more local leaders into the meeting at which county plans were made. The State or assistant State club leader and the county extension agents continued to direct the making of the county plans, but the viewpoint of the people in the county was given greater recognition than previously.

In each of the Central States attention was given to better training of local 4-H club leaders for their work by means of the county conferences. A majority of the States prepared mimeographed or printed helps for conducting such conferences. Seven States conducted State-wide conferences for leaders during the annual 4-H club week.

The extension budget for the Central States for the fiscal year ended on June 30, 1930, amounted to \$8,069,740. The personnel on this date consisted of 17 extension directors and assistants, 49 county agent supervisors and assistants, 915 county agricultural agents and assistants, 28 home demonstration supervisors and assistants, 215 county home demonstration agents and assistants, 60 club supervisors and assistants, 98 county club agents and assistants, and 458 subject-matter specialists.

SOUTHERN STATES

The Southern States administrative division includes the States of Alabama, Arkansas, Florida, Georgia, Louisiana, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, and Virginia. J. A. Evans, associate chief of the office, was regional supervisor for these States during the year.

One of the most outstanding and gratifying features of the work in the South is the growing realization on the part of extension forces of the need for a more closely coordinated program from both State and county standpoints. Supervisors as well as specialists seem to be thinking more in terms of assisting the agents in planning more definitely and in executing such plans, and there is a gradual disappearance of the so-called patent projects which have been previously peddled by the specialists with very little thought to application in a county.

This assistance rendered to the county agents by the supervisors and specialists is going far toward making the county agent a more permanent fixture in the county. It is necessitating less argument on the part of the supervisor for maintaining the agent in the county, as the efficiency of the work speaks so well for itself that frequently the supervisor does not need to visit the county prior to the making of an appropriation for financing the work.

The salaries of agents are gradually increasing and there seems to be less turnover in the counties notwithstanding the fact that very desirable positions are being offered in commercial lines which attract many of our best agents. In Tennessee, the State legislature has provided sufficient funds to offset the Federal appropriation and put the county agents on State and Federal finances. There is a great tendency in this direction, and when it is possible to accomplish this the worries of many county agents will automatically disappear since they now fear to foster a marketing or purchasing program for the farmers because of local opposition to such effort.

A thorough study is being made by supervisors, as well as by specialists, of problems which concern economic production of the various enterprises fostered in program building by the agents in the counties. This study of experimental data and its application in the county is causing the entire force to more thoroughly adopt the practices recommended by the experiment station to the county programs.

A still more thorough study is being made of the demonstration itself. The question frequently arises whether or not a demonstration really demonstrates, and of course the demonstration is fashioned after the practices recommended by the experiment station. The results secured in the county are so obvious that the agents are rapidly becoming more interested in the demonstration as the foundation of the work and in securing records which will serve as bases for constructive thinking, not only on the part of the agent but of the advisory council or board working with the agent in developing programs.

There is a growing interest in the development of plans suitable for extending programs worked out in cooperation with the advisory board, and the organization of these plans on a calendar basis. Many of the plans have to do with solving the problems indicated, and with methods of imparting the information secured through the demonstration, and otherwise, to a larger group of farm people.

A more general use is being made of field meetings and tours. The extension forces are intensely interested in methods of conducting field meetings and tours so as to attract greater attention and to give a more widespread knowledge of the results discussed at such meetings. There is also improvement in the publicity that is being developed by the county agent. He is getting more results to serve as a basis for good news items, and because of this fact there is a decided increase in interest on the part of the local papers. County agents are also developing better circular letters to call attention to meetings or to make other announcements.

A greater interest has been developed in the educational type of exhibit. This is being substituted for the agricultural display which usually has no educational feature. Educational exhibits often are

used to illustrate a problem in a county and to suggest its solution. Facts previously established by demonstrations serve to render such exhibits more valuable.

This more general use of various agencies is keeping extension work before the public throughout the year in such a manner as to hold its attention on certain problems and their solutions. Both the supervisors and the county agents feel that a more concentrated effort along fewer lines of endeavor will produce results more rapidly, and there is a decided tendency in that direction.

Agents are interested in securing better pictures of their work in order to record it in visible form. A good many agents are experimenting with a small camera which does not require close adjustment. These small pictures often serve as a basis for the development of a series of slides or film strips. There is a growing interest in the use of film strips made up of local subjects, especially at winter meetings, to further advance some particular project.

As the county work grows in magnitude and interest there is an increasing demand to have agents keep longer office hours. Many supervisors are seeking to help agents work out a system of office management and filing which will enable them to find readily the materials needed to answer office calls and correspondence. Two States have adopted a uniform filing system, and one State is furnishing both men and women, white and colored, with a complete file for storing the information data needed by the agent.

Supervisors are spending more time with the agent in studying the progress that has been made with the various phases of work carried on in the county. If a more thorough study along this line can be obtained, it will be possible in a few years' time to determine more accurately the controlling factors of successful county agent work. There is also a growing tendency on the part of the supervisor to study his own work, and to make plans which will assist him in recording the weak points of the various agents in his territory, and which will focus his attention on these weak points when he visits the county.

On July 1, 1929, 649 white county home demonstration agents and assistants and 125 negro county home demonstration agents were employed in the 12 Southern States. This was an increase of 110 new county home demonstration agents since July 1, 1928. There were 796 county home demonstration workers, 76 supervisors, and 43 home-economics specialists, or a total of 915 women extension workers employed in the 12 Southern States on June 30, 1930. This increase in the number of agents is an indication of how the influence of successful results is spreading even in view of hard times, shortage of funds, drought, and economic retrenchment of county officials in many of the States. Through real service to the farm family and the farm home, the county home demonstration agent last year proved her practical and financial worth to the voters as well as to officials in the counties, especially where she had through establishment of profitable demonstrations pointed the way to development of the resources of the farm homes and the farm communities.

During the fiscal year ended June 30, 1930, \$4,679,035 was allotted from all sources for the purpose of carrying on home demonstration work in the United States, and of this amount \$2,274,379 was to be

expended in the South. In 1928-29 the total allotment was \$4,245,927, of which \$2,071,582 was to be spent in the South. In 1929-30 the special funds available for relief work in the devastated area of the Mississippi Valley amounted to \$59,500, of which it is estimated 46 per cent was used for home demonstration work.

The total appropriation of \$1,480,000 was available in 1930 from the Capper-Ketcham Act and greatly aided in the furtherance of home demonstration work. Approximately \$436,493 of this fund was used in the Southern States, and of this 45 per cent was for home demonstration work.

The formation of county home demonstration councils constitutes the most important progress made in perfecting the organization side of home demonstration work in the South. These councils have been of paramount importance in spreading the influence of the most successful demonstrations of possible returns and benefits derived from the adoption of improved methods of farming and home making. The development of leadership in these council members has relieved the agents of a great many details in the local club affairs in connection with county and State fairs, local commodity organizations, school-lunch work, and the like. Members of the county-council group were also of great assistance in working up interest in unorganized sections of the county and in developing county-wide plans of work and programs. Members of county councils, after studying the census report for their county concerning the garden, dairy, and poultry situation, decided that certain demonstrations were needed in each section of the county in order to assist in raising the standard of living throughout the county. They then prevailed on club members to undertake these demonstrations.

In 649 counties now employing home demonstration agents in the Southern States there are organized 843 county home demonstration councils for women and girls. Many counties have separate councils for the work with women and with girls. In Texas, where they now have 85 county home demonstration councils well organized and functioning, special consideration is given in each of these councils to the economic background of the farm home. Every county home demonstration council was to study and make a census report this year for the county concerning the food and feed needs. County plans have been made accordingly.

Home-improvement work among both women and girls has held the greatest interest in the minds of home demonstration club members and agents throughout the South. There were 338,418 women and girls enrolled and pledged to give reports on results obtained in many different phases of this work. The most interesting part of the home-improvement demonstrations can be found in the description of various means used to bring about these desired results. Furtherance of productive and profitable creative activities has been fundamental in plans of work for the majority of home demonstration agents. During 1930, 915 home demonstration workers employed in the Southern States definitely helped about a half million women and girls to raise farm standards of living. In all their work, the agents' efforts have been to improve standards of beauty, comfort, culture, influence and power, and the results show not only splendid achievement in the productive and economic side but

also wonderful progress in living accomplishments. During the past year there has been an increase in the number of livable homes in the country, but the contentment and satisfaction resulting from beautifying and improving the farm homes can not be measured, and this is the most important part of the results achieved.

Through the rearrangement of equipment, improvements made in planning housework, and the addition of homemade and purchased conveniences and labor-saving devices more and more of the farm home maker's time has been released for gainful and healthful recreation and occupation out of doors. The women's enthusiasm in such work has stimulated interest and cooperation among other members of the family and neighbors. The development of this type of healthful cooperation and interest has unlimited possibilities in the improvement of living conditions in the country. A home demonstration agent in Texas has written that she frequently finds an entire family has a new outlook on life because of results obtained by a club girl who has undertaken some phase of home-improvement work.

In many States county-wide, home vegetable-garden contests were sponsored by local newspapers, chambers of commerce, women's federated clubs, and other organizations of business men and women. Their interest in conducting such contests was usually based on the needs of the county. At the State fair in Mississippi, results of county contests in home vegetable gardens were exhibited in order to show some of the possibilities of year-round gardens in Mississippi. More than 18 counties showed improved varieties of many kinds of vegetables. One county exhibited a collection of 48 kinds of vegetables, and each of the next 3 counties having the best assortment in the exhibit included 47, 46, and 38 varieties. None of the 18 county vegetable-garden exhibits showed less than 22 varieties of vegetables. In addition to the vegetables shown each county exhibited an educational poster describing uses of vegetables in the diet. Some of these were extremely interesting.

Poultry work was given an important place in the year's plans of work in hundreds of counties because of the possibilities for almost immediate financial returns. In Oklahoma, poultry raising for some time has been one of the leading state-wide production activities and is carried on in each county where a home demonstration agent is employed. In 30 counties in 1929, poultry was the major demonstration activity. The State agent has reported that each county home demonstration agent in Oklahoma emphasizes the proper management of home flocks, feeding, housing, and disease control. Poultry demonstrations were carried on by more than 2,000 women and about 1,500 girls. The poultry work in Oklahoma has made notable advances through the farm-flock demonstrations, egg shows held at schoolhouses and at county and State exhibitions, through judging and culling schools, and through county poultry federations. During National Egg Week, 25 to 30 counties in Oklahoma annually hold egg shows where thousands of dozens of eggs are exhibited. Nearly a thousand birds have been shown at a school-house poultry show as a result of the home demonstration agent's efforts. Each child is required to stand by while his or her birds are judged, and each year the number of disqualified birds exhibited is

decreasing. The poultry-show day in the community is one of the big days of the school year.

In 1929 different phases of home dairy work have been emphasized by home demonstration agents in some counties in several of the States, especially where the farm women have become interested in marketing farm-home butter and cottage cheese for better prices. In Alabama more than 300 farm women, who are sellers at club markets, have improved their methods of butter making. Through practical demonstrations in butter-making and butter-judging contests much interest has been aroused in the making of better butter. At least 1,000 farm women in Alabama and as many or more in a number of other Southern States were enrolled to major in home dairying last year. Home dairying is an important part of home demonstration work. Thousands of women are learning the feeding of better dairy rations and the sanitary production and care of milk. Besides a program in dairying for the regularly organized clubs, the use of an adequate supply of milk in the diet was emphasized in all clubs among girls and women.

The home-improvement and home-beautification projects more than ever enlisted the interest of farm women. In 1929, 76,933 farm women carried out plans for the beautification of home grounds; 98,393 women were enrolled in home-garden clubs; 27,415 in home-dairy work; and 68,599 in home-furnishing clubs. Home health and sanitation attracted an enrollment of 54,558 women; 90,847 women and 141,985 girls were enrolled in clothing work. Altogether, 130,374 girls and 101,109 women were instructed in food preparation, and 113,796 women and 112,644 girls in food preservation. The work of home demonstration agents showed encouraging results in improved health and living conditions in the rural sections of the South.

Four-H club work in the Southern States continued to grow in 1929. The enrollment in boys' clubs was 143,785 and in girls' clubs 210,570, a total of 354,355. Of this number, 206,940 turned in complete records. Reports show continued improvement in organization and instruction to members. Boys and girls put on demonstrations in the Southern States in more than 50 projects. Splendid results were obtained, although in many sections climatic conditions were unfavorable. The average yield of corn made by 18,037 boys throughout the territory was 38 bushels per acre in 1929. Several of these boys raised more than 100 bushels on their acres. The average yield of seed cotton of all boys reporting in Alabama, Arkansas, Georgia, and Mississippi was 1,148 pounds per acre. In Anderson County, S. C., 295 boys raised a bale of cotton or more to the acre. Of these boys, 193 made an average of 702 pounds of lint cotton to the acre. This is an outstanding result.

While the boys did such excellent work on the farms, the girls did as well in the homes. A total of 65,413 demonstrations in food preservation, 49,381 in nutrition, 33,810 in house furnishings, 42,081 in beautification of home grounds, and 14,777 in home management, and many other demonstrations, show conclusively that the girls were not idle.

In the production of crops such as corn, cotton, and vegetables, the 4-H clubs have been used to great advantage. In some sections the

types of cotton and corn have been changed by furnishing purebred seed to the boys. These boys have demonstrated to their fathers that the best corn and cotton can not be grown without good seed. In Surrey County, Va., the negro club members have caused a complete change in the types of corn grown by their fathers. In the past the yields of these two crops grown by boys were from two to three times as large per acre as the same crops grown by their fathers. Boys and girls have also demonstrated that year-round gardens can be grown and fresh vegetables supplied through the larger part of the year.

Probably the most noticeable thing done by club work in the South is the change in the types of livestock grown. In every State much interest is being shown by 4-H club members in the growing of purebred livestock. In the sections adapted to beef cattle, club members are raising excellent specimens, but more interest in the States is taken in the raising of dairy calves. This has aroused the interest of many county agents who have heretofore done no club work. In one county in North Carolina there was an agent who said that he could not do club work. In 1929, he was induced to secure a number of dairy calf club members and at the close of the year when plans were being made to purchase calves, he desired a carload to be furnished for his county. In Alamance County, N. C., negro children own 63 head of registered Jersey calves.

When club work was begun in the South, the section was noted for its razor-back hogs. These are becoming very scarce. The boys and girls joining pig clubs secured purebred stock. The most popular breeds are Poland Chinas, Duroc-Jerseys, and Berkshires. They sold the increase from their pigs to their neighbors, and in this way good hogs have been distributed throughout the territory.

In many homes, especially among the poorer class of people, little nutritious food was cooked, and that was poorly prepared. To-day, through the efforts of the home demonstration agents, the girls belonging to 4-H clubs have been taught proper methods in the preparation of food for the table. Starting with tomatoes, the gardens of club members to-day furnish fresh, nutritious vegetables for the table throughout the growing season and canned products throughout the winter. As a result of club work, food of better quality which is better prepared is found upon numerous tables.

Camps were held in most of the counties in the Southern States where club work is organized. In numerous instances the boys and girls own their own camps. In Louisiana the university is making appropriation to promote 12 camps in the State so that a camp will be in reach of every boy and girl in the State. Camp Grant Walker has been established for several years. In Virginia the boys and girls were aided in establishing a permanent camp at Jamestown, where the first settlement was made. The Chesapeake & Ohio Railway Co. helped them to establish this camp. In Florida a permanent camp was established on a Government reservation on the Gulf of Mexico. Boys and girls usually spend a week at these camps. Instructions are given on the demonstrations they are making at home and in recreation. They are taught to sing together, to play together, and to cooperate to the good of all. The interstate meetings are valuable to the farm boys and girls. Their success in making demonstrations wins them trips into other States. A large number

attend the interstate fair at Memphis, the National Club Congress at Chicago, and four from each State come to the National Boys' and Girls 4-H club camp at Washington, D. C. The leader-training school at Springfield, Mass., has a boy and girl from each of the Southern States in addition to the Moses trophy winners. The recreational side of club work has a wonderful effect in inducing boys and girls to become club members.

WESTERN STATES

The Western States include Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming. W. A. Lloyd, who is in charge of the cooperative relations of the office with these States, completed a year's furlough in October, 1929, during which he organized and directed extension work in Hawaii. During his absence, C. B. Smith, chief of the Office of Cooperative Extension Work, took direct charge of extension work in the Western States.

During the year extension programs were planned and executed in 5,891 communities under the guidance of extension workers. In carrying out these programs excellent assistance was given by 27,389 farm men, women, and older boys and girls who volunteered their services as county, community, or local leaders. Of this number, 20,642 leaders worked with adults and assumed the responsibility for placing demonstrations, training local demonstrators, holding field meetings, and conducting tours. Assistance was given by 6,747 leaders who helped 4-H club members to carry on their demonstration activities. Volunteer leaders were given extension training at 2,523 meetings, at which the attendance was 30,516. Reports indicate that increased dependence was placed on local leadership in enlarging the scope of extension influence. The county extension agent utilized every effective device in making contacts with farming people. Office days were maintained, during which 713,000 requests for assistance were received and information supplied; more than 212,300 visits were made to about 106,000 farms to give help to farmers; and 38,897 visits were made to 23,760 homes to aid farm home makers. A total of 39,319 news items regarding demonstrations and other extension activities and informative articles were supplied to the farm press. More than 28,900 method-and-result demonstration meetings were held, with an attendance of 638,000; and farmers' institutes, extension schools, and short courses had an enrollment of 71,588.

County agents in the 11 Western States are constantly improving their methods of arriving at their agricultural programs and the effectiveness of their methods of putting them over. During the year agents continued to make effective use of demonstrations, news notes, meetings, and tours. Probably the most striking changes were in connection with program planning and the increased use of outside organizations to increase the rapidity with which extension goes over.

Six years ago the idea of a state-wide regional and county economic conference as a method of building an extension program grew out of the challenge on the part of certain organizations to the agricultural colleges that these institutions did not have an agri-

cultural policy. This challenge brought to the attention of the different college staffs the fact that a large part of the work at the institution, as well as in the field, related to methods of improving cultural practices. After various institutions began to study the actual changes that the farmers were making and where the most expensive errors were occurring, they began to realize that most farmers had as serious a problem in connection with the readjustment of their enterprises to meet the market demands without serious loss as with improving production methods. It also became evident that the farmer might grow the right combination of crops, be efficient in his enterprise, and still not have sufficient funds at the end of the year to get his family the things they most needed and the things which they considered they should not do without.

As this idea of organizing facts upon which to base a program has developed, new methods have been devised. In the beginning most of the facts related to past trends of the various enterprises in the different agricultural areas, to markets, and conditions in competing areas. From an analysis of these gathered facts, the farmer determined what enterprise should be increasing or decreasing and to what extent. In these studies, data were gathered not only with reference to cost but also to time and effort put into the various operations and the returns due to the various methods followed. The subject-matter specialists, farm-management demonstrators, and county agents have all participated in the gathering of these data and analyses.

In practically all of the Western States the idea of getting a detailed farm-management record or survey from 25 or more farmers in the county is being used more extensively than ever before. However, these records have been given a new use. In the past, if the receipts were sufficient to pay all the farm expenses and a certain percentage on the investment, the farm was considered successful, but when the idea that the farm not only was to pay interest on investment but also to provide the family with a living was introduced, many of the farmers that were considered successful under the old way of thinking failed to meet this new requirement. The county agent, subject-matter specialist, and farm-management demonstrator are adding to the idea of efficiency, as it relates to the individual enterprise, the idea of having a sufficient number of units to give a net return that will provide the family with the minimum essentials of good living.

When data relating to dairying were first organized, there was very little information at the institutions which showed what changes had taken place in the dairying industry during recent years, what was bringing about these changes, and how rapidly the industry should be developed in the future. This absence of data led the directors to request the United States Bureau of Agricultural Economics to bring together the basic facts relating to dairying. From a study of these data it became evident to the dairy specialists and the workers in dairy counties that the expansion of the dairy industry should be in accordance with the growth of the population, principally in cities along the Pacific coast, and that as this population grew the dairies near large cities would turn more and more to the production of whole milk and the production of butter and cheese would take place farther in the interior.

In one area, the county agent found that the average age of the cows in the county was 8 years and that cows were being kept on farms until they died from old age because there was no market outlet. He succeeded in establishing a cooperative shipping association to get rid of the aged cows, thereby improving the quality. In another area the county agent was striving to establish a few herds from which the farmers could get high-grade bulls and thereby improve the quality of their dairy stock. In many instances the cow-testing association has developed a method of picking out and eliminating boarder cows. In Idaho it was a part of the program of specialists and county agents not only to eliminate the boarders but also to get a line on bulls which had the quality of improving the yield. In order to determine this the bulls had to be kept in service for a considerable period and ways and means provided whereby these older and more dangerous animals could be handled safely.

As a result of this program many good sires have been discovered and placed in breeding herds.

Among the difficulties that the county agent has had in building up dairying on a safe basis has been the overenthusiasm of bankers, commercial clubs, and other organizations which had not had an opportunity to study the basic facts with reference to this industry. With the data furnished by the United States Department of Agriculture and State agricultural colleges these people have been able to assist the county agents in meeting many difficult situations.

In a Colorado county, as a result of an economic conference, the beef men decided that due to the increasing amounts of feed produced the fattening of beef cattle should become a part of their ranch operations. They also agreed to hold a feeder sale each fall, organize a 4-H beef club to fatten cattle, and get a few of the farmers to keep records on the cash receipts and expenses, amounts of feed used, and the results obtained. Since these various influences were brought to bear on the situation, numbers of animals are being fattened locally, and the system of farming is gradually changing from the production of feeder animals to the production of a more finished type.

In a number of areas where poultry has been an important farm enterprise poultry producers have united in shipping associations. These shipping associations have not only been influential in finding a market but by the grading of the poultry and eggs have made the farmer conscious of the quality of his product and its relation to the price he is receiving. In addition, they have convinced him that under most conditions the highest annual profit comes from producing eggs in relatively large numbers when the price is high. These associations have also been effective in providing the farmer with the right kinds of feeds at the right time of the year. Similarly the formation of shipping associations among the turkey producers and grading the product locally have enabled the producer to see where his methods have been inefficient and to cooperate with the county agent and poultry specialist in securing the right kind of breeding stock, in feeding, and in fattening his birds so as to put them on the market in the most satisfactory form.

The extension work with wheat is another example of how the county economic conference forms a background for an extension

program that takes into consideration not only biological and physical factors but also economic influences. In Oregon a variety of wheat was developed at one of the substations which was apparently well adapted to the counties in the area. The county agents, after demonstrating its superior qualities for a year, interested the elevator operators in the superior quality of this wheat and the opportunity that they had in increasing the yield through paying a premium for certified seed of this variety, treating and cleaning it, and turning it back to the farmers at a reasonable profit to themselves but at a price which farmers could afford to pay. As a result of this activity in less than five years most of the wheat grown in the area was of this variety.

In Montana the county agents felt that the local people had a problem not only in the planting of the right variety but also in their methods of handling the soil. Therefore they interested both the producers and the implement dealers in determining what methods of cultivation to use and what implements gave the greatest satisfaction under local conditions. Again, the organizations dealing with farm supplies were fully as important in the improving of methods of production as the efforts of the farmer himself.

County agents in their fact-organization activities are not only improving their technic in handling facts but also in presenting the facts to the farm people as a basis of action. The general plan for the organization of a county economic conference is to have all those in attendance assigned to an enterprise or commodity committee. To stimulate attendance at these conferences a determined effort has been made to get in contact with those farmers who have been successful in handling the particular enterprise in which the county agent wishes to secure their cooperation. By securing the cooperation of this group of farmers through joining in the discussion and analyzing local agriculture as well as utilizing their successful experience, the county agent has a much better background for his extension program than he has had in the past, when he had depended upon a limited number of farmers used in an advisory way. In addition, through this process the test and demonstration stage in connection with many of the practices that he wishes to advocate is eliminated and the experiences, recommendations, and cooperation of farmers become the basis for his systematic organized extension program. Many agents feel that their plans will speed up the farmers' accomplishments from 10 to 25 per cent.

Because of great distances in a large number of Western States, systematic county organization of home demonstration interests has perhaps come more slowly than in some other sections of the country. Effort has gone to the strengthening of community groups or organizations to make possible county organization when the opportune time comes. There has been marked progress in the past two years in the organization of home demonstration work from the county standpoint. The States in which county organizations have been set up in at least a part of the counties are Washington, Nevada, California, Montana, Colorado, and Utah. New Mexico and Wyoming have the matter under discussion and consideration.

These county organizations have various names; for example, the Thurston County Home Makers' Council in the State of Washington.

The county councils in Washington are made up of the presidents and secretaries of the community groups. They meet three times during the year to discuss problems pertaining to the whole county. With the cooperation of county extension agents decisions are made with reference to such matters as the county women's vacation camp, county projects, equipping and maintaining a county demonstration kitchen, fostering 4-H club work, and school nutrition.

In Colorado, all members of the community clubs are members of the county organizations. The presidents of the community clubs make up the executive committee which attends to the business matters. The county meetings held once each month are planned largely to act as a training meeting for leaders, and it is thought that the interest stimulated reflects back into the community groups.

Montana has county advisory councils which meet several times during the year. California's organization is the farm-bureau type. The chairmen of the home department in each community comprise the county committee of the home department of the county farm bureau. The county committee meets each month. Nevada also has a county farm-bureau organization. In Utah can be found both farm-bureau organizations and county home demonstration advisory councils.

In the past three years Montana, Washington, Oregon, Colorado, Wyoming, and Nevada have held county or district economic conferences in which the farm-home interests have been considered. These conferences were not held in connection with agricultural conferences. Farmers, however, were welcome to attend these conferences and take part in the committee discussions. These county home conferences get the headlines in the county and local papers and bring home demonstration work before the general public in a convincing way. The home demonstration forces and the farm women enter into the discussions in a businesslike way and most enthusiastically. Farm-home interests have been considered at some of the county or district agricultural economic conferences. The committees considering home interests usually have small attendance. Cooperation of agricultural and home-economics extension forces is equally as hearty when such conferences are held at different times, and these much-desired conditions are brought about by other means more than by joint conferences.

Utah is making a more elaborate study of home conditions than most States which undertake the county conferences. It is thought in Utah that very definite detailed information should be obtained from 50 or more homes in a county to reenforce and supplement the more general information obtained before an economic conference is held.

The development and use of local leaders has been one way of reaching a larger number of people with extension information. The Western States are making progress in shaping the different phases of projects into units which can be handled well by local home demonstration leaders and have prepared excellent instructions and subject-matter material to aid the local leaders. All States hold leader-training meetings.

The project leaders representing the different communities in the county are trained by the county home demonstration agent, usually

2 leaders from each community. Each project leader within seven days meets with and trains 4 neighborhood leaders, each of whom gives the demonstration before 3 other farm women. These 3 in turn meet with 2 others and each of the 2 with 1. In each step of the plan effort is made to reach some women who have not been in regular attendance in the home-demonstration or farm-center groups. Report blanks are furnished each leader in order that a check can be secured on the scope of their activities.

There have been no decided changes in the management of the vacation camps for farm women in the past three years. Experience, of course, has meant that each year in any State the camps are better organized from a physical standpoint and that the program is improved. There is less serious project or subject-matter instruction given and more recreational features and rest periods provided than four or five years ago, in the early days of the camps. The type of instruction given is usually effective, because interesting, illustrative material is used in the talks and demonstrations.

There were 36 camps for farm women conducted in the States of Arizona, California, Idaho, New Mexico, Montana, Washington, and Wyoming with a reported attendance of 6,736, representing 104 counties. These camps are popular with the farm women and have served as effective publicity in acquainting the general public with the home-economics program and activities.

Progress has been made in reorganizing foods and nutrition projects for girls, but the enrollment is still too low. Many States have included growth and health ideals in their 4-H club projects for girls and in their club camps. Most States have held State health contests and sent contestants to the interstate contest at Camp Plummer, but little organized growth work has been done with club boys. There have been many junior garden clubs. On the whole, the junior branch of the nutrition program needs strengthening.

The early developments of the clothing program were based on garment construction, and that interest still holds. There is no decrease in the results of the instructions given in garment construction and making over garments, but there has been developed in the clothing program a greater appreciation of clothing in its relationship to health and to appearance. The farm women are learning to sense beauty in line, color, and design. They are learning better selection of textiles and materials in buying and what to expect in quality of workmanship, material, and appropriateness of style when purchasing ready-made garments. Most States have projects which give special instructions in the construction and hygiene of children's clothing.

The various phases of the clothing program that were conducted in 1929 in the several Western States can be listed as follows: Type pattern and its use, alteration of commercial patterns, garment-construction technic, garment finishings, remodeling of garments, hat making, construction of children's clothing, layettes for infants, clothing of the 4-H club girl, selection of materials, how to buy ready-made clothing, selection and care of clothing, dry cleaning, laundering, self-care of clothing by children, efficient closets for storage, sewing equipment, care and use of sewing machine, body and clothing hygiene, and judging clothing exhibits.

Home management is a project of diversified interests. In order to extend the information necessary, there is need for close cooperation between several specialists and sometimes with several of the teaching and experiment station departments of the college. There is a marked increase of interest and cooperation of the several forces in contributing to and conducting the home-management project. Rural-engineering specialists or departments are cooperating in plans for house building or remodeling, and water, drainage, heating and lighting systems for rural homes. Farm-management specialists are furnishing data regarding farm incomes. Some of the Purnell research workers are conducting projects dealing with household accounts and time schedules in housework. The chemistry departments cooperate in problems dealing with hard water and other household-chemistry problems. Yard improvement is sometimes included in the general home-improvement projects, which brings in the horticultural specialist.

The surveys of farm-home conditions that have been made in several States and their discussion at the county economic conferences have given impetus to home-improvement phases of the home-management program. The facts regarding conditions sometimes are surprising, and what has been taken for granted is not always the true condition. This fact finding plays an important part in determining the home-management program.

The various phases of the home-management programs that were conducted in 1929 in the several Western States can be listed as follows: Installation of improved home equipment (hand and power washing machines, refrigerators, pressure cookers, and the like); kitchen improvement (emphasizing rearrangement for convenience, heights of working surfaces, sanitary floors and walls, built-in equipment, storage space, tools for every task); home accounts; time schedules and task studies (systematic planning in housework); laundry problems; house planning and remodeling; water; drainage; heating and lighting system; better-home tours.

House-furnishing activities when given specialized attention are supervised by the home-management or clothing specialist. California is the only State in the West which employs a house-furnishing specialist. In most States the house-furnishing project has centered around the improvement of the living room and the improvement of the 4-H club girl's room. This interest sometimes acts as an incentive to extend the improvements to the whole house and also to the surroundings or the farmstead. When specialized extension help is not available, or the time of the agents will not permit detailed attention, or the finances of the farm home are insufficient for even the small expenditure usually made, the improvement of a whole room is not taken as the unit, but simple, inexpensive improvements are encouraged, which means far more comfort and attractiveness.

Several States have made a special feature of the convenient closet, attention being given to arrangement and accessories as shoe pockets or cabinets, hat bags, garment protectors, and a convenient place for children's clothing. California and Montana have developed plans and demonstrations in better bedrooms with attention to ventilation, bed springs, mattresses, mattress covering, bedding, color backgrounds, rugs, furniture, and accessories.

Child development and parent education is a special field of home economics work which is being set up in some States as a special extension project. In the Western States up to the present time child-development and parent-education phases have been introduced into other projects; foods and nutrition, clothing, health, and sanitation. This seems to be a logical procedure. Good growth and development phases are incorporated throughout most projects in California. The Western States that are giving special thought and some action to plans for further development are Utah, Montana, Nevada, California, Arizona, and Wyoming.

In the Western States, the county home demonstration agents are responsible for the home-economics projects in girls' club work in the counties. The only exception is in a very few counties where there is a county club agent who gives full time to club work.

In the States where an appreciable number of older girls are staying in club work, larger units of work are being planned by the leaders and specialists for these young women. They are interested in advance phases of clothing, foods and nutrition, house furnishing, and home management. One most gratifying development in the West is the continued and increased cooperation of the State home economics specialists in the girls' club work. Each Western State has worked out more systematic training of local club leaders by well-prepared instructions, subject-matter circulars, and training meetings.

One of the outstanding accomplishments in the past six years in the Western States is the realization on the part of a larger number of county extension agents that boys' and girls' club work is an important part of their job. Records of previous years indicate that 95 per cent of the 116 county home demonstration agents in the 11 Western States and 85 per cent of the 273 county agricultural agents conduct club activities in the counties to which they are assigned. In addition there are 67 assistant county agricultural agents who in many cases give practically full time to club work.

During 1929 there have been no important changes in the plans of organization of club work in the communities and counties. The standard club idea where certain requirements are held, for example at least five members doing the same project, is the general type of organization. There are, however, a good many sparsely settled communities in the West where it is not practicable to have anything but a mixed-project club. Club leaders and members in some cases travel long distances to attend club meetings. Generally throughout the West the club program is adopted as an integral part of the community extension program.

A decided improvement has been made in the past two or three years in the keeping of permanent records of individual club members in the county offices. Especially good systems have been worked out in Montana and Colorado. Montana reports that many of the counties have records from the very beginning of club work, 10 or 12 years ago. Such records are invaluable where there is a change of agents in a county and are advantageous and businesslike from many standpoints.

College 4-H clubs, made up of former club members, are organized on the campuses of the State agricultural colleges in Washington, Oregon, Wyoming, and Idaho. These organizations are for the purpose of bringing together all former club members for

sociability, to be responsible for welcoming incoming club members and helping them to adjust themselves to college life, and to provide a means of contact with the extension service by which it can not only help these former club members but also derive benefit from their suggestions and assistance.

Advances are being made in training leaders in all the Western States, but at least six States have systematic plans. In general, volunteer leaders assist the county extension agents in developing and carrying out the club program by (1) supervising programs at meetings and events, (2) notifying club members of meetings, (3) assisting in distributing club literature, (4) assisting in enrolling club members and organizing clubs, (5) checking record books, (6) making farm and home visits, (7) acting as general adviser to club members, and (8) assisting with exhibits, tours, and achievement days.

Two States, Utah and California, hold volunteer-leader conferences for a week at the agricultural colleges. Local-leader conferences are held at the colleges in Washington, Oregon, Idaho, and Arizona in connection with the State club encampments. There were in attendance at the California club leaders' course 149 leaders, and at the Utah State training school 88 leaders representing 21 counties.

One of the most outstanding undertakings in training volunteer leaders has been the series of five district conferences held in California so that a larger number of leaders could have the benefit of special training. Two of these conferences were 3-day affairs; each had representation from eight counties, and each was attended by 81 leaders. The delegations were divided into seven committees; program making, county-club council, achievement day and tours, community and individual projects, demonstration teams, recreation, and agricultural and home-demonstration projects. These committees considered the particular interests assigned to them and developed plans for future execution which were reported in general assembly for further discussion. The other three district conferences were 1-day affairs with attendance varying from 40 to 90.

The Western States during the year have made use of the services of John Bradford, of the National Playground Association (Inc.), which was formerly the Playground and Recreation Association of America. He has been assisted in some States by John S. Knapp, a dramatic specialist of the same organization. In the past two years Mr. Bradford has given instruction in rural recreational activities at leader-training meetings and at State club encampments in California, Oregon, Washington, Utah, Wyoming, Arizona, Colorado, and Idaho. Mr. Bradford and Mr. Knapp held 11 recreational institutes in California alone in 1929 which were attended by local leaders and extension agents. No doubt this specialist training will mean much toward the social and recreational activities in the communities where extension work is conducted.

On June 30, 1930, there were employed in the Western States 665 extension workers, 34 more than in the previous year. The extension staff in this region included 16 extension directors and assistants, 15 county agricultural agent supervisors, 273 county agricultural

agents, 67 assistant county agricultural agents, 14 home demonstration supervisors, 113 county home demonstration agents, 3 assistant home demonstration agents, 13 4-H club supervisors, 21 county club agents, and 130 specialists. There was an increase of 11 in the number of home demonstration agents and assistants, an increase of 13 in the number of county agricultural agents and assistants, and a reduction of 2 in the number of county club agents. The total amount of the funds allotted for extension work in the 11 Western States was \$3,143,145.

HAWAII

One of the newest developments of great interest during the year 1929 was the organization of home demonstration work as an integral part of the extension service in the Territory of Hawaii. Prior to 1929 an occasional group of women had been reached through talks or demonstrations conducted by members of the staff of the Federal experiment station. This general type of service received its first impetus during the war. With the establishment of the cooperative extension service at the University of Hawaii has come organized home demonstration work similar to that on the mainland. The assistant director for home economics, Elmina White, and the four home demonstration agents in the counties of Honolulu, Hawaii, Maui, and Kauai, have studied home conditions as they exist by making home visits, and at the same time gaining the confidence of the women. Martha Eder, Kauai County, made 110 home visits in 5 months, while Hazel Zimmermann of Hawaii County visited 140 different homes in 10 months. On the basis of needs, the home demonstration programs have been started with promising results in the few months. The number of communities that have under way an extension program for women and also with club girls are listed by counties as follows: Hawaii, 11; Honolulu, 10; Kauai, 16; Maui, 7.

One of the interesting developments of club work in 1929 was the reorganization of club work in the Territory of Hawaii. Boys' and girls' club work was started in the Territory of Hawaii in 1923-24 by the Hawaii Agricultural Experiment Station. Mabel Green was appointed club leader. The club work was conducted in close cooperation with the public schools, the clubs being organized within the schools, the teachers acting as leaders and giving most of the project instruction during school hours. In 1926 the club work had extended to four counties.

Since the organization of cooperative extension work at the University of Hawaii in October, 1928, club work has been reorganized, independent of the schools, and with the same requirements as those on the mainland. There are now four counties organized in extension work with four home demonstration agents and five county agricultural agents on duty, each of whom is conducting 4-H club work. During the year a total staff of 22 was recruited, including a territorial agent each in animal husbandry, forestry, and sugar technology.

EXHIBITS

During the fiscal year 1930 the Office of Exhibits continued under the direction of Joseph W. Hiscox. No important changes in personnel occurred. The Washington personnel at the end of the year numbered 26, and that at the warehouse and shops in Alexandria, Va., 11.

FINANCES

Fifty-seven organizations desiring exhibits, located in 27 States and the Republic of Mexico, deposited \$9,633.06 during the year to cover costs of movement of exhibits, an increase of approximately 23 per cent over deposits for the previous year. By States the number of organizations cooperating in this way was as follows:

Alabama, 1; Arizona, 2; Arkansas, 1; Colorado, 1; Florida, 3; Georgia, 2; Illinois, 4; Iowa, 2; Kansas, 2; Maine, 1; Massachusetts, 2; Michigan, 4; Minnesota, 2; Missouri, 3; Montana, 2; Nebraska, 2; New Hampshire, 1; New Jersey, 4; New York, 2; North Carolina, 1; Ohio, 1; Oklahoma, 2; Pennsylvania, 2; Tennessee, 3; Texas, 1; Washington, 4; and West Virginia, 1.

A national road congress in Mexico City was the cooperating agency in Mexico, a special good-roads exhibit having been sent for this occasion. The regular appropriation for exhibits at State, interstate, and international fairs was \$120,000. In addition approximately \$18,000 of a special appropriation for exhibits at the Fourth World's Poultry Congress, \$26,900 of a similar appropriation for an exhibit at the International Fur Trade Exhibition and Congress, and the deposit of \$9,633.06 previously mentioned were expended, making available practically \$175,000 for exhibit work. Nine units of the department contributed the sum of \$678.40 from their own appropriations for renovation, trucking, shipping, and replacement in storage of exhibit material for display at occasions not specified in the provisions of the exhibits-appropriation item.

During the year exhibits equivalent to 731½ standard units were completed, 11 were extensively revised or rebuilt, 120 were renovated, and 5 were under construction at the close of the year. Compared with the previous year, this was an increase of approximately 18 new exhibits built. The increase was due largely to the building of large groups of exhibits for showing at the International Fur Trade Exhibition and Congress, at Leipzig, Germany, and at the Fourth World's Poultry Congress at London, England.

Probably the outstanding development was the preparation of exhibits for these foreign expositions. The handling of this work by the regular preparation staff, with a small amount of additional help for a short period, was made possible by careful planning. Renovation of exhibits, which is usually started late in November after the exhibit for the International Livestock Exposition has been completed and shipped to Chicago, was begun this year early in the fall. Because of the very extensive program of revision the previous year it was necessary to revise extensively only 11 of the existing exhibits, the remainder being renovated only. Renovation was completed early in the spring, so that when the special appropriation for the building of the International Fur Trade Exhibition and Congress exhibit did not become available for expenditure until April 11, the way was clear for its prompt handling. This exhibit, which occupied nearly 5,000 square feet of floor space, exclusive of aisles, was completed for shipment on May 2. It was necessary also to complete the exhibit for the Fourth World's Poultry Congress by the end of June, this exhibit occupying more than 3,000 square feet of floor space. These activities were, of course, in addition to those involved in the regular program of production of new exhibits for State fairs and expositions.

PREPARATION METHODS

Exhibits of the animated type in which mechanical action is synchronized with sound and speech have continued to attract much attention. Two more exhibits of this type were produced, namely, "Advice from an Old Ewe" and the "Beef Cattle Outlook." These exhibits dramatize certain fundamental truths by means of reproductions of short playlets or acts. In the one which presents the control of stomach worms in sheep, the characters are an old ewe, a young lamb, and the owner of the flock. They carry on a conversation through the aid of certain motions and gestures and a specially prepared phonograph record, phonograph, and amplifier. An operator synchronizes the actions of the characters with the record. In the exhibit entitled, "Beef Cattle Outlook," the characters are a ranchman and his son. These figures are equipped with movable arms and movable jaws, the faces being made of soft rubber. The phonograph record reproducing the speech is synchronized with the movement of the jaw and the arm of each man as his part of the dialogue is reached.

Continued study is being given to the possibilities of the use of color absorption in obtaining an effect of illusion in the exhibits. This principle has been used in one or two instances with success, and it is believed that it is capable of much wider adaptation. This and other factors offer a fertile field for experimentation, and experience indicates that there is need for a small research section to solve various exhibit problems. Any experimentation which is done now must be accomplished in connection with the production of an actual exhibit, which usually is scheduled for showing at a definite time. If the new method fails, there is danger of failure to meet the obligation. A committee representing the International Association of State Fairs and Expositions which studies the work of the Office of Exhibits recently recommended that a research section be established. They felt that the research which might be conducted would be a direct benefit to all exhibit work in this country.

EXHIBIT AT THE FOURTH WORLD'S POULTRY CONGRESS

Plans for the department exhibit at the Fourth World's Poultry Congress at London, England, were started early in the year and by late fall had developed to a point where structures for a large part of the exhibit could be ordered. Work on this exhibit was continued until early in April, when the money for the International Fur Trade Exhibition and Congress exhibit became available and it was necessary to drop all other work in order to concentrate on the production of the fur exhibit. The poultry exhibit was completed later and shipped from Washington, D. C., on June 25. The exhibit consists of six main divisions as follows: Breeding for egg production, history of incubation and brooding, nutrition, the poultry industry of the United States, marketing poultry, and marketing eggs. Each of these divisions is illustrated by a structure 24 feet long and 21 feet deep. The columns, cornices, fronts, and similar equipment were produced in England on contract to avoid the necessity of transporting such bulky material. All of the exhibit equipment, models, and the like produced by this office were so made that they could be folded or otherwise reduced in bulk to reduce the size and weight of the boxes and crates.

THE INTERNATIONAL FUR TRADE EXHIBITION AND CONGRESS EXHIBIT

While the exhibit at the International Fur Trade Exhibition and Congress at Leipzig, Germany, was discussed for several months prior to the congressional action authorizing participation by the United States, no expense could be incurred in connection with its preparation until April 11, which gave approximately three weeks for building and crating the exhibit, the latest date for shipment from New York being May 2. Early in the calendar year, the United States Department of Commerce, which was also interested in this exposition, agreed that the exhibits for the two departments should be built by one organization, thus insuring a harmonious exhibit with unity of purpose. On the basis of this arrangement the entire appropriation was allotted to the United States Department of Agriculture for expenditure. Preliminary plans for the exhibit and for the purchase, assembly, and preparation of materials necessary to its completion were made well in advance of the time the money became available. As far as conditions permitted, work was placed on contract, personnel was borrowed from other divisions, and the help of organizations in other departments was obtained. At the time the material was shipped, it was estimated that the exhibit was 95 to 97 per cent complete, and the remaining articles which were not available on the shipping date were later boxed and sent to Leipzig. It was only through the unusual cooperation of the Department of Commerce, the Department of Agriculture shops and photographic section, and the Bureau of Biological Survey that it was possible to complete this very large and rather elaborate presentation in time to have it installed for the opening of the exposition on May 31.

COOPERATIVE WORK

The demands for assistance in planning exhibits and for information on methods of building and sources of exhibit materials and talent appear to be increasing. In addition to the requests for help in planning, several requests to prepare complete exhibits have been received from agricultural colleges. The language of the appropriation item does not permit this form of cooperation, but it is felt that with authority and adequate preparation for handling this type of work valuable assistance could be given to State colleges and extension services.

EXHIBITION DIVISION

Between July 1, 1929, and June 30, 1930, exhibits were shown at 78 fairs and expositions within the continental United States. Forty-five of the 1929-30 exhibitions were at State, interstate, and international fairs as compared with 40 exhibitions of the same character in 1928-29, 37 in 1927-28, and 35 in 1926-27. At least a carload of exhibits was shown on each occasion.

While the number of all types of exhibitions increased steadily from 1926 to 1929, and the number of carload exhibitions at State, interstate, and international fairs increased approximately 30 per cent, the work was done without increase in personnel in the exhibition division. During this period changes in personnel have resulted in replacement of experienced persons by others without experience, but the result previously noted has been obtained by co-

operation, overtime work, curtailment of annual leave, and use of form letters for correspondence wherever possible.

From 1926 to 1928 salary and travel costs for department personnel assigned to installation and demonstration were steadily reduced. In 1929, however, the task of field arrangement and movement was heavier than could be handled economically, resulting in personnel costs to the department rising to an average of \$63 per State-fair exhibition over the 1928 season. Table 1 gives data covering personnel costs at fairs.

TABLE 1.—*Comparison of exhibition personnel costs at State, interstate, and international fairs, 1926–1929*

Item	1926	1927	1928	1929
Exhibitions.....number.....	35	37	40	45
Man-days.....do.....	1,172	943	877	1,131
Total department salary cost.....dollars.....	8,636.54	6,450.32	6,319.39	8,343.00
Total department travel and subsistence cost.....do.....	12,472.81	7,875.78	6,685.45	9,117.75
Cost per exhibition.....do.....	603.12	387.19	325.12	388.02

The small increase in the exhibits appropriation available during the fiscal year was used in the preparation of improved exhibits and in sharing with the bureaus of the department the expenses for travel and subsistence of exhibition personnel which previously had been borne mainly by the bureaus. The new plan provided that the Office of Exhibits and the bureaus each would pay half of such travel and subsistence. The increased number of exhibitions at State and interstate fairs, however, required more personnel than the bureaus furnished, necessitating a further draft on the Office of Exhibits. As a result, the exhibits appropriation bore approximately 70 per cent of the travel and subsistence expense of exhibition personnel instead of sharing this equally with the interested bureaus.

COOPERATION WITH FAIRS

No material changes were made in the cooperative exhibition plan which has been in effect for several years except that by improvement in the exhibits and in methods of handling in the field the cooperative costs to the fairs were somewhat decreased. The department provides the exhibits and personnel for their installation and demonstration. The fairs furnish the transportation by deposit in advance, exhibition space, storage for shipping containers, drayage and labor for unloading and reloading cars; common labor for unpacking, installing, dismantling, and repacking the exhibits; janitor, watchman, electrical, and such other services as are required to accomplish a creditable display.

Studies to reduce railroad freight hauls between fairs, to lessen return hauls, and to shorten periods of inactivity of exhibits between exhibitions were continued, and as a result another \$5 reduction was made in the prorated transportation deposits, making a decrease by \$5-steps annually from \$185 per carload per fair in 1926 to \$165 for the 1930 season. The following statement shows the cooperation given by fairs:

Summary of cooperation by fairs, season of 1929-30

Deposit to cover transportation charges-----	\$7, 793. 86
Value to exhibition space-----	40, 000. 00
Trucking (unloading and loading exhibits)-----	1, 847. 75
Installation and dismantling labor-----	1, 227. 89
Miscellaneous exhibit expenses-----	674. 95
Total-----	51, 544. 45

Results from the use of electric feed cable mentioned in last year's report have been gratifying. Superintendents of electrical installation at fairs have commended these cables highly. The expense to the fairs for electrical connections in most instances have been reduced to a negligible amount. Only a few minutes of an electrician's time are required to attach main wires to the safety-switch boxes which control the exhibit circuits. These circuits are composed of sections of heavy-duty stage cables that hang along the backs of exhibits. Each section is equipped with outlets for the lights and electrical apparatus, and heavy-duty connectors are attached to each end. To form a continuous circuit the prong connector of the first section is plugged into the receptacle connector of the switch box and the prong connector of each succeeding section into the receptacle connector of its contiguous section. Two such circuits are used with each of the regular carload exhibition groups which, in addition to saving expense, enable complete disconnection at night from building current mains.

At its session in Washington, D. C., in the spring of 1929, the International Association of Fairs and Expositions committee on Government exhibits recommended that the Office of Exhibits develop a plan whereby exhibits could be installed in the various departments of the fairs, such as the livestock, dairying, poultry, and conservation departments, instead of in a large single block of space. The space situation, the committee stated, had become acute with most of the fairs, but in many instances fairs which were no longer able to provide single large blocks of space still might provide smaller blocks in the departments which in the aggregate would equal the quarters formerly provided.

The manager of the South Florida Fair at Tampa offered his fair for an experiment with the new plan. The result was that apparently the exhibits, by being departmentalized, are visited by the persons most interested in the particular subject matter. The South Florida Fair arranged with superintendents of departments and interested exhibitors in those departments to help look after the exhibits. The regular representatives of the Office of Exhibits visited all the exhibits frequently and maintained them in good operating condition. Under conditions similar to those at the South Florida Fair it is believed that exhibits may be distributed among the various departments of a fair without detriment to the success of the exhibition. This plan is likely to be useful at important fairs where the accommodation of department exhibits in a single area is no longer possible.

Exhibitions conducted during the year are shown in Table 2.

TABLE 2.—*Exhibitions conducted during fiscal year ended June 30, 1930*

Place	Occasion	Dates
Atlanta, Ga.	Southeastern Fair	Oct. 5-12, 1929.
Albion, N. Y.	Orleans County Fair	Sept. 18-21, 1929.
Ames, Iowa	Farmers' Home Week	Jan. 27-Feb. 1 1930.
Atlantic City, N. J.	American Road Builders' convention	Jan. 13-18, 1930.
Bethany, Mo.	Northwest Missouri State Fair	Sept. 3-7, 1929.
Birmingham, Ala.	Alabama State Fair	Sept. 30-Oct. 5, 1929.
Boston, Mass.	International Textile Exposition	Apr. 28-May 3, 1930.
Chambersburg, Pa.	Franklin County Fair	Sept. 10-12, 1929.
Chehalis, Wash.	Southwest Washington Fair	Aug. 20-25, 1929.
Chicago, Ill.	International Livestock Exposition	Nov. 30-Dec. 7, 1929.
Cincinnati, Ohio	National Crushed Stone Association convention	Jan. 20-22, 1930.
Coldwater, Mich.	Health and Home Institute	Nov. 6-8, 1929.
Columbus, Ohio	Farmers' Week, State University	Feb. 1-8, 1930.
Do.	Animal husbandry exhibit at Ohio State Fair	Aug. 26-31, 1929.
Detroit, Mich.	Michigan State Fair	Sept. 1-7, 1929.
Ebensburg, Pa.	Cambria County Industrial Exposition	July 1-6, 1929.
Effingham, Ill.	Daily Record cooking school demonstration	Dec. 10-13, 1929.
Escanaba, Mich.	Upper Peninsula State Fair	Sept. 16-21, 1929.
Hamline, Minn.	Minnesota State Fair	Aug. 31-Sept. 7, 1929.
Hutchinson, Kans.	Kansas State Fair	Sept. 14-20, 1929.
Jacksonville, Fla.	Get-together meeting	Feb. 20-22, 1930.
Do.	Florida State Fair and Exposition	Mar. 15-22, 1930.
Kankakee, Ill.	Kankakee Interstate Fair	Aug. 12-17, 1929.
Kansas City, Mo.	American Royal Livestock Show	Nov. 16-23, 1929.
Knoxville, Tenn.	East Tennessee Division Fair	Sept. 23-28, 1929.
Lake City, Fla.	State Forest Fair	Nov. 13-15, 1929.
Lewiston, Me.	Maine State Fair	Sept. 2-5, 1929.
Lincoln, Nebr.	Nebraska State Fair	Aug. 30-Sept. 6, 1929.
Little Rock, Ark.	Arkansas State Fair (two groups)	Oct. 7-12, 1929.
Los Angeles, Calif.	Sixth Annual Food and Household Show	Apr. 20-26, 1930.
Memphis, Tenn.	Mid-South Fair and Dairy Show—Poultry Show	Sept. 28-Oct. 5, 1929.
Do.	Mid-South Fair and Dairy Show—National Cotton Show.	Do.
Do.	Mid-South Fair and Dairy Show—All-South 4-H Club Congress.	Do.
Minneapolis, Minn.	International Baby Chick convention	July 29-Aug. 2, 1929.
Do.	Hennepin County Public Health Association	Sept. 30-Oct. 5, 1929.
Missoula, Mont.	Western Montana State Fair	Sept. 17-20, 1929.
Moultrie, Ga.	Second Annual Hog School	Jan. 14-15, 1930.
Do.	Southwest Georgia Swine Show	Oct. 20-27, 1929.
Muskogee, Okla.	Oklahoma Free State Fair	Sept. 28-Oct. 5, 1929.
Nashville, Tenn.	Tennessee State Fair	Sept. 17-22, 1929.
Newark, N. J.	Food and Health Exposition	Mar. 24-29, 1930.
Olympia, Wash.	Biological Survey Exhibit	September, 1929.
Omaha, Nebr.	Ak-Sar-Ben Stock Show	Nov. 1-5, 1929.
Orlando, Fla.	Central Florida Exposition	Feb. 18-22, 1930.
Peoria, Ill.	The Greater Peoria Exposition	Aug. 25-31, 1929.
Phoenix, Ariz.	Arizona State Fair	Nov. 11-16, 1929.
Portland, Oreg.	American Medical Association convention	July 1-8, 1929.
Prescott, Ariz.	Northern Arizona State Fair	July 4-7, 1929.
Pueblo, Colo.	Colorado State Fair	Sept. 16-21, 1929.
Puyallup, Wash.	Western Washington Fair	Sept. 16-22, 1929.
Raleigh, N. C.	North Carolina State Fair	Oct. 14-19, 1929.
Rochester, N. H.	Rochester Fair	Sept. 24-29, 1929.
Saginaw, Mich.	Saginaw Fair	Sept. 8-14, 1929.
St. Louis, Mo.	The Sportsmen's Show	May 12-18, 1930.
Do.	National Dairy Exposition	Oct. 12-19, 1929.
Do.	National Dairy Exposition—Poultry Show	Do.
Spokane, Wash.	Spokane Interstate Fair	Sept. 2-7, 1929.
Springfield, Ill.	Illinois State Fair	Aug. 18-25, 1929.
Springfield, Mass.	Eastern States Exposition	Sept. 15-21, 1929.
State College, Pa.	Farmers' Week	June 18-19, 1930.
Syracuse, N. Y.	Exposition of Syracuse University	May 1-3, 1930.
Tampa, Fla.	South Florida Fair	Jan. 28-Feb. 8, 1930.
Trenton, N. J.	Trenton Interstate Fair	Sept. 30-Oct. 5, 1929.
Do.	New Jersey Farm Products Show	Jan. 13-18, 1930.
Tulsa, Okla.	Tulsa State Fair	Sept. 14-22, 1929.
Valdosta, Ga.	Georgia Forest Fair	Nov. 21-23, 1929.
Waco, Tex.	Texas Cotton Palace	Nov. 1-10, 1929.
Waterloo, Iowa	The Dairy Cattle Congress	Sept. 30-Oct. 6, 1929.
Washington, D. C.	Washington Barracks Military Show	Oct. 2-5, 1929.
Do.	Industrial Exposition	Oct. 21-26, 1929.
Do.	Spontaneous heating and igniting conference	Nov. 14-15, 1929.
Do.	American Automobile Association convention	Mar. 17-22, 1930.
Do.	Pharmacopœia convention	May 10, 1930.
Wheeling, W. Va.	West Virginia State Fair	Sept. 1-7, 1929.
Wichita, Kans.	Southwest Road Show and School	Feb. 25-28, 1930.
Wilmington, Del.	Du Pont Co. demonstration	May 13-15, 1930.
Yakima, Wash.	Washington State Fair	Sept. 9-14, 1929.

MOTION PICTURES

The Office of Motion Pictures continued with the same organization as during the preceding year, with Raymond Evans as chief and C. A. Lindstrom as associate chief.

Twenty-three persons were employed on a permanent basis in the Office of Motion Pictures at the close of the fiscal year. The permanent personnel was supplemented during the year by temporary employment of 4 technicians, 3 actors, 2 clerks, and 2 messengers, as necessary.

The office suffered serious loss during the year in the deaths of Howard Greene, technical animator, and William H. Weible, film editor and cinematographer.

FUNDS

In addition to the item of \$63,060 for motion pictures in the appropriation for farmers' cooperative demonstration work, funds were provided by bureaus of the department, through cooperative arrangement with the University of Maryland, and by special appropriation for the production and exhibition of films at foreign exhibitions, as follows:

Cooperative project, University of Maryland, (\$10,000) expended during 1930-----	\$1, 030. 33
Cooperation with bureaus of the Department of Agriculture-----	14, 952. 78
Fourth World's Poultry Congress-----	7, 000. 00
International Fur Trade Exposition and Congress-----	1, 686. 10
Total-----	24, 669. 21

DISTRIBUTION

Pictures are loaned without cost, the borrower paying transportation costs from and to the laboratories at Washington, D. C. Although, with the introduction of sound in conjunction with motion pictures, there has been a definite drop in demand for silent films in the commercial field, the demand for department motion pictures continued to exceed the supply of films available. The office made 3,368 film shipments during the year of 6,398 subjects, totaling 9,990 reels. It was necessary to turn down requests for 1,035 subjects because of inadequate supply of films. Reported attendance, about 70 per cent complete, totaled 2,541,240. A conservative estimate of the total attendance is over three and one-half million. As more department pictures have been sold to schools, colleges, and other agencies for distribution, it is probable that the grand total of attendance at showings of pictures produced by this office totals over 7,000,000. This is a reduction over last year's attendance, attributable to the introduction of the "talking" pictures, and is an indication of the trend and of the necessity for talking pictures in educational work.

Copies of films purchased by educational institutions, foreign Governments, and the like during the year totaled 419, or 121 more than for the preceding year. Great interest in the films was shown in foreign countries, 254 being sold abroad. The largest single order was from the Director of Agriculture of Uruguay, who purchased 114 copies. In addition, films were sold into the following foreign countries: Argentina, Canada, Chile, Colombia, Cuba, Holland,

India, Japan, Lithuania, Nicaragua, South Africa, and Union of Socialistic Soviet Republics.

An experimental circulation of 16-millimeter (narrow width) film was started during the year with a view to determining what, if any, demand existed for this type of film. Twenty copies of selected films were released on February 15. Since that time shipments have averaged four a month. It is too early to determine whether the demand is great enough to warrant enlargement of this service.

Two copies each of nine films were sent to London, England, for exhibition in connection with the World's Poultry Congress. Three films were sent to Leipzig, Germany, for exhibition in connection with the annual International Fur Trade Exhibition and Congress.

RELEASES

Twenty-two new pictures were completed during the year, of which 110 copies are available for distribution, as shown in Table 3.

TABLE 3.—*New motion pictures completed during fiscal year 1930*

Picture	Reels	Copies
Cooperative Marketing—Eggs and Poultry (3 reels).....	9	3
The Egg-Marketing Industry in the United States (2 reels).....	4	2
Grain Grading (2 reels).....	16	8
Lamb—More Than Legs and Chops (2 reels).....	10	5
Poultry Marketing in the United States (5 reels).....	10	2
Breeding for More and Better Eggs (2 reels).....	4	2
Brooding and Rearing Chickens (2 reels).....	4	2
Layers or Loafers? (1 reel).....	2	2
The Turkey Business (1 reel).....	2	2
The Eastern Woodchuck and Its Control (2 reels).....	14	7
The Fur Industry of the United States (3 reels).....	9	3
Friends of Man (4 reels).....	52	13
Green Pastures (1 reel).....	1	1
New Woods for Old (2 reels).....	26	13
On a Thousand Hills (1 reel).....	11	11
Selective Logging (1 reel).....	6	6
Date Culture in Iraq (2 reels).....	4	2
Concrete Road Construction (2 reels).....	16	8
Low-Cost Road Surfaces—1st Stage (2 reels).....	16	8
Low-Cost Road Surfaces—2d Stage (1 reel).....	8	8
Highways of Brazil (1 reel).....	1	1
Highways of Argentina (1 reel).....	1	1

SOUND PICTURES

The sudden advent of the “talking” motion picture has necessitated a change in the type of picture produced. No more silent “story” pictures are being made, and straight educational films are so assembled that an accompaniment of sound may be easily added at a later date.

Experimentation in sound recording and projection has been continued during the year. A disk sound-projection apparatus has been purchased, and two existing pictures have been synchronized and will be available for release shortly. Progress in the development of sound pictures necessarily is slow. The budget and facilities of the office are based on past needs for silent pictures and are wholly inadequate for the installation of sound equipment and the much greater costs of the production of sound pictures. However, preparations have been made during the year to begin production as soon as facilities can be made available.

REPORT OF THE CHIEF OF THE FOOD AND DRUG ADMINISTRATION

UNITED STATES DEPARTMENT OF AGRICULTURE,
FOOD AND DRUG ADMINISTRATION,
Washington, D. C., September 20, 1930.

SIR: I submit herewith the report of the Food and Drug Administration for the fiscal year ended June 30, 1930.

Respectfully,

W. G. CAMPBELL, *Chief.*

Hon. ARTHUR M. HYDE,
Secretary of Agriculture.

INTRODUCTION

The Food and Drug Administration¹ is a distinctly regulatory unit. Its research activities are limited to those made necessary by the demands of law enforcement and its service work is entirely incidental to the regulatory operations. Research problems can ordinarily be completed and reported as finished projects. The volume of service activities may be shown by statistics. Regulatory operations do not, however, readily lend themselves to presentation in an annual report. Completed regulatory projects are rare. Forms of violations apparently checked have a disconcerting habit of reappearing and calling for renewed regulatory activity. Statistical statements of the number of samples collected, prosecutions undertaken, and seizures made illustrate certain features of the regulatory work, but do not disclose in full measure the actual progress, in the course of a year, in improving the purity and honesty of the food and drug supply. An annual report of the Food and Drug Administration, therefore, must largely be restricted to matters which are typical of its work and indicative of the trend in the industries subject to control.

The administration has assigned to it for enforcement the food and drugs act, the insecticide act, the import milk act, the naval stores act, the tea act, and the caustic poison act. Because the food and drugs act is unquestionably the most important to the welfare of the American people, and because the activities under that act consume the bulk of the administration's appropriation and energies, the greater part of this report is devoted to a discussion of the food and drugs act work.

¹ The appropriation act for the fiscal year ended June 30, 1928, authorized the establishment of the Food, Drug, and Insecticide Administration. The act for the year ending June 30, 1931, authorized a change in name. On July 1, 1930, the organization became the Food and Drug Administration. This involved no change in duties or organization.

PUBLIC INTEREST RENEWED

A gratifying feature of the food and drugs act enforcement activities during the year has been the evidence of renewed public interest in the measures taken by the Government to insure a wholesome, pure, and honest food and drugs supply, a development decidedly encouraging. During the years immediately preceding the passage of the food and drugs act, great public interest existed because of extensive publicity given those glaring abuses which emphasized the need for remedial legislation. The measure was carried through Congress on a wave of popular approval, and for some years after its passage the violations which were made the subject of action, under the law, were of a sufficiently sensational character to be featured as important news in the daily press. Scandalous abuses, such as the sale of dead horses as beef, promptly detected and stamped out under the law, caught and held public interest. As these startling forms of adulteration and fraud were corrected, and as the enforcement work became more routine in character and better organized, the activities of the officials received less publicity. The general public began to accept the protection afforded by the law as a matter of course, this attitude in certain quarters almost approaching forgetfulness. The result has been that efforts to weaken the law by amendment, which have not been infrequent during the past few years, have not met with the popular opposition that the importance of the matter deserved. At the same time a certain amount of credence has been given to those who, for their own reasons, have seen fit to announce that the food and drugs act is no longer enforced, and the protection guaranteed by the law to the consumer has been withdrawn. It is easy for the uninformed public to draw the conclusion that activities on which the daily press is largely silent are nonexistent.

The food and drugs act, in addition to definite prohibitions of injurious and debasing forms of adulteration, imposes certain positive labeling requirements which, if fully understood by the purchaser of foods and drugs, will be of great economic value to him. If the consumer, furthermore, fully understands the limitations of the law he will be better able to protect himself in his purchases by giving full value to those label declarations subject to control, and by discounting advertising matter of an extravagant kind not subject to the jurisdiction of the law.

During the past year the Food and Drug Administration has received numerous inquiries about the scope of its food and drug control work, and has a growing appreciation of the need of more general public enlightenment about the food and drug law operations. Some very definite steps to this end have therefore been taken. With the cooperation of the departmental radio service, an extensive series of radio talks descriptive of the law-enforcement work has been planned and broadcast. A special feature has been one series intended to instruct consumers in the intelligent reading of food and drug labels. An effort has been made to inaugurate a "Read-the-Label" movement among the housewives of the country, which has met with a gratifying and enthusiastic response. Similar material has been prepared for publication in the daily press and in periodicals, and facilities have been accorded to independent writers to enable them to prepare articles descriptive of the administration's work.

PLAN OF ENFORCEMENT

Operations under the food and drugs act must be within the legal scope of the act and must be kept strictly within the amount appropriated, to cover salaries, laboratory upkeep, equipment, travel, purchases of samples, cost of court trials, and the like. Interstate and import traffic in foods and drugs, subject to the law, exceeds \$15,000,000,000 annually. This traffic has increased enormously since the World War. It has frequently been noted that the inadequacy of facilities established for its control has become more apparent as the population and the volume of commerce have increased. Confronted with the problem of controlling traffic of this magnitude with admittedly inadequate facilities, and with a statute limited in some respects in scope, the administration must determine how it can insure the maximum protection to the consumer with the force at its disposal. One established principle is cooperation of the closest possible character with Federal, State, and municipal agencies having like interests and authority. This insures against costly and unnecessary duplication of effort, and guarantees teamwork in the control of violations. An office of State cooperation has been maintained in the administration for years to facilitate the interchange of information between State, city, and Federal enforcing officials, and to insure effective cooperation in the interest of the public.

The 23 years during which the Federal food and drugs act has been in operation have not only produced many clarifying court decisions, indicative of the scope as well as the limitations of the law, but they have also pointed out the systematic course of administrative procedure which will guarantee the maximum benefits to the American public. It has been clearly demonstrated that an indiscriminate sampling of food and drug products, while it may, by the law of averages, reveal numerous violations, leaves much to be desired in the way of uniformity of public protection. It has been likewise established that the development of legal action against every definite violation encountered, without regard to its significance from the public health or economic standpoint, would promptly involve the enforcing agency and the courts in a mass of more or less trivial actions, while serious violations from the consumer's standpoint proceeded unchecked. On the other hand, it has been demonstrated with equal force that the entire personnel and appropriation granted for the law-enforcement work could be utilized annually in a meticulous supervision of the interstate and import traffic in one or two staple commodities. It has been estimated, for example, that a thorough sampling and analysis of every interstate shipment of two such staple commodities as flour and butter would more than absorb the entire annual appropriation for the enforcement of the law. Obviously, neither course of enforcement procedure is in the best interests of the public.

The method of enforcement developed after more than two decades of experience is known as the project plan. It is based on a few simple principles. (1) The most complete knowledge possible on the part of the enforcing agencies, of the practices in every branch of the food and drug industry, to guarantee prompt detection of probable violations and the identification of those manufacturers

whose operations are likely to require surveillance. (2) Uniformity of regulatory action throughout the United States, where the same type of violation is involved. (3) Enlightenment of all manufacturers and shippers who are bringing products within the jurisdiction of the law as to the legal requirements imposed upon them, in order to insure a maximum degree of voluntary compliance by that great majority of food and drug manufacturers who are honestly endeavoring to market legal products. (4) The classification of offenses in the order of their importance, from the standpoint of public health and economic interest, with a concentration of regulatory activities against those most serious.

Since it has been made evident through many years of law enforcement that most American food and drug manufacturers are disposed to meet the literal requirements of the law, the administration does not hesitate to utilize a part of its funds and appropriations in demonstrating to manufacturers legal methods of manufacture, where such educational methods apparently will insure more effectively a pure and unadulterated product to the consumer.

This was the practice of the Bureau of Chemistry from the beginning of its enforcement operations in 1907. The Food and Drug Administration has unhesitatingly followed the precedent thus established. Such educational and advisory methods supplement but do not replace formal prosecution and seizure. Failure to take advantage of the opportunities afforded for a voluntary compliance with the law inevitably leads to the institution of legal action. A large part of the force of the administration is distributed throughout the United States in inspection stations located at strategic points for the control of both import and domestic traffic. These stations are equipped with laboratory facilities and manned by chemists, inspectors, and others necessary for the conduct of the work. Under the uniform plan of action provided in the project system the first duty is to learn, through inspections of manufacturing plants, those practices in the manufacture and distribution of foods and drugs which may lead to adulteration and misbranding and to identify the concerns likely to indulge in them. With this fundamental information, obtained at the source, probable offenses are divided into the following classes, in the order of their importance from the standpoint of the ultimate consumer:

1. Offenses involving the public health, such as foods containing added poisons and worthless medicines offered for serious disease conditions.

2. Offenses against decency, such as the distribution of decomposed or filthy foods.

3. Adulteration or misbranding involving serious economic cheats detrimental both to consumers and to honest manufacturers.

Admittedly a regulatory plan of this kind presupposes neglect of less important and more technical violations. Therein lies a fertile source of criticism, for the Food and Drug Administration must in the course of a year's operations inevitably refrain, as a matter of deliberate policy, from attacking certain definitely recognized violations because of the more pressing demands from the consumer's standpoint for activity in checking those of a more serious nature.

FOOD AND DRUGS ACT

In the course of the interstate and import operations during the year, approximately 36,068 samples of foods and drugs were collected and examined. The examinations in a large number of cases consisted only of chemical analysis, but a material percentage of the total number of samples analyzed required supplementary bacteriological, microscopical, or pharmacological examination. This aggregate includes not only samples upon which legal actions were based, but those of an unofficial or informal character collected as a guide for determining the necessity of regulatory operations. In a great many individual prosecutions and seizures it was necessary to collect and examine several samples in the course of developing the cases. Tables 1 and 2 contain condensed summaries of the actions taken under the domestic and import provisions of the act, respectively.

TABLE 1.—*Summary of prosecutions and seizures under the food and drugs act, fiscal year ended June 30, 1930*

Item	Prosecu- tions	Seizures	Total
Foods.....	63	571	634
Drugs.....	49	314	363
Stock feeds.....	56	52	108
Total.....	168	937	1, 105

TABLE 2.—*Import samples examined at port laboratories during fiscal year ended June 30, 1930*

Item	Detained	Released	Total
Foods.....	2, 247	3, 514	5, 761
Drugs.....	1, 186	1, 348	2, 534
Total.....	3, 433	4, 862	8, 295

In addition, many thousands of floor inspections were made of both food and drug consignments offered for entry.

Penalties in bonds collected during the year amounted to \$41,349.81.

No attempt is made to present a detailed report of each regulatory action, but different classes of offenses are illustrated by typical cases encountered during the year.

FOOD ADULTERATIONS INVOLVING PUBLIC HEALTH

Foods may become dangerous through contamination with poisons, through the development of certain forms of bacterial decomposition, or through the presence of disease germs.

An example of added poison is found in fruits and vegetables containing excessive amounts of arsenical residues, resulting from the employment of sprays of lead arsenate as a protection against insect pests. A systematic campaign to determine the character of sprayed fruits and vegetables entering interstate commerce and their status under the provisions of the law was inaugurated in 1919. Succeeding seasons have seen increased activity until at present the

project has attained such importance that during the shipping season much time of the field force is devoted to this work.

During the past season 3,347 samples were examined for arsenic. Fortunately, there is a realization on the part of the industry of the importance of shipping only safe products and a commendable spirit of cooperation has been exhibited. There has been a very general adoption of methods developed by the department and by collaborative State agencies for the removal of arsenical residue by appropriate cleaning processes. Therefore it was seldom necessary during the year to resort to legal action. Analyses made by our own laboratories and the laboratories maintained by the States and by producing and shipping agencies have shown it sufficient to confine the work largely to a determination of the quantity of residue present at maturity. The reporting of excessive residue has almost invariably led the responsible owner to employ successful cleaning processes. Failure to adopt such methods inevitably leads to the detention of the product, by appropriate legal action, until cleaning can be effected.

There are all too frequent cases of poisoning, where the poisonous material is added to the home food supply quite by accident, generally through carelessness. Ordinarily such cases do not fall within the purview of the food and drugs act. A striking example of this kind is the case of nine fruit cakes, made by a housewife living near Falls Church, Va., and distributed at Christmas time. The cakes with one exception were sent to people in the immediate vicinity. The shipment to Canada of one purchased from the housewife brought the matter within the jurisdiction of the food and drugs act. The facts in the case and samples of the cake were brought to the attention of the administration, and quick action in collecting seven of the cakes before they had been cut undoubtedly prevented serious illness and probably death. An inspection problem of a serious kind was presented in the case of the Canadian shipment. The purchaser had expressed the intention of shipping the cake to Canada. When the poisonous character of the cake was discovered, the purchaser had disappeared and the name and address of the Canadian consignee were unknown. Persistent and ingenious work by the inspector assigned to the task finally disclosed the probable destination of the product. Cooperation on the part of those directly concerned, the Canadian legation in Washington, and Canadian authorities, finally resulted in retrieving the cake before it had been cut. Analysis showed it to contain an amount of arsenic which might easily have proved fatal. The true facts as to how arsenic became mixed with the flour used in the cake will probably never come to light, but a thorough investigation pointed to carelessness in keeping a bag of arsenical spray material in close proximity to the family flour supply, and within reach of several small children. The gravity of the incident led the administration to issue a warning to housewives to keep household poisons carefully stored and at a safe distance from food supplies.

Botulism is a type of food poisoning having a high mortality. It is due to the *Bacillus botulinus* which finds a natural host in the soil and in certain nonacid vegetables. Such vegetables, insufficiently processed in canning, may develop a toxic condition highly dangerous to those partaking of them.

A case in point was reported in the last annual report. It resulted in the death of one man and the serious illness of another and was caused by eating canned shallots, or onions, packed in Italy.

Occurrences of this kind emphasize the importance of careful scrutiny of food products showing evidences of decomposition. During the past year the administration has been diligent in examining samples of imported and domestic foods which might be expected to harbor dangerous organisms.

Fortunately, no cases of botulism attributable to commercially packed foods occurred in the United States during the 12-month period.

During the year, however, 16 outbreaks of alleged food poisoning were investigated. Laboratory examinations were made of 51 samples, comprising 29 different foods suspected of being the cause of illness. In many cases the results of the examinations disclosed that suspicion of the food was unfounded. In five cases, however, pathogenic bacteria capable of producing symptoms of food poisoning were isolated from the samples submitted for examination. Two of these cases involved sausage, in one case homemade and in the other a commercial product contaminated and improperly handled in a local retail establishment. In two other cases bakery cakes were found to contain toxic bacteria. In the fifth case sandwiches, contaminated in their preparation for use on a picnic, were proved to be the cause of the illness.

In three of the five instances of proved food poisoning the illness was shown to be due to the use of products undoubtedly contaminated and improperly stored on the premises of the consumer or in the local retail market. In the case of the bakery cakes no shipments or sales were made within the jurisdiction of the Federal food and drugs act. Prohibition of the use of these cakes was enforced by the proper local authorities.

The cases of food poisoning investigated during the fiscal year 1930 were of the type usually diagnosed as ptomaine poisoning, in which the bacteria responsible for the illness are almost invariably introduced into the product during local handling or in the process of preparation for the table.

FOOD ADULTERATIONS INVOLVING OFFENSES AGAINST DECENCY

In the second group of law violations may be classed offenses against esthetic taste. Examples of this class are worm-infested fruit and various decomposed and filthy foods.

An ever-present problem involving filth in a food supply is that of the control of traffic in fresh, dried, and canned fruits infested with worms.

Of the work conducted by the administration on the subject of insect-infested fruit, that on figs is prominent. When in 1926 it was found that from 10 to 12 per cent of the California fig crop was condemned under the provisions of the food and drugs act, it was realized that the situation demanded some action on the part of food officials that would furnish additional information for use in administrative matters and at the same time serve as a guide to the

growers and packers of figs and give them a better understanding of proper methods of handling their crops.

Beginning with 1927, the administration has sent a representative to California each year who has spent the season examining hundreds of samples of figs, devising means of detecting infestation, and by cooperating with packers, growers, and official agencies, assisting in improving the quality of the product. The investigation has continued from year to year with increased knowledge of the situation and a corresponding improvement in methods of handling the problem. Hundreds of samples of figs from the trees, from the ground under the trees, from picking boxes, from the grading shed, and from the packages ready for shipment are examined. A pamphlet prepared at the close of the year was widely distributed in California during the harvesting season. This pamphlet was written for the purpose of giving reliable information in regard to fig testing and the proper handling of the fruit during harvesting, storing, and packing. Its recommendations have been largely adopted by the fig industry with a corresponding improvement in the quality of figs offered to the American consumer.

The work on figs not only includes the fresh product but has been extended to include dried figs and fig paste. During the year approximately 800 official samples of dried figs and paste have been analyzed, 22 seizures representing 25,210 pounds have been made, and 663 ranches and factories have been inspected.

Supervision of importations of figs has been continued. During the calendar year 1929, 625 lots (a total of 20,725,310 pounds) of imported figs were examined. Of these, 2,853,840 pounds were re-exported, and approximately 870,000 pounds were destroyed because of the wormy and moldy condition of the figs. In addition, seizure was made of over 46,000 pounds of figs entered illegally in violation of the importer's bond.

Since 1922 the control of maggots in the blueberry output of the Maine canneries has been a subject of active investigation on the part of the administration. Personal supervision at the canneries, methods devised for the removal of maggots, a public-service patent issued to members of the administration for a process of maggot removal, and general cooperation with canners and State officials resulting in practically placing the blueberry-canning industry on a firm basis are all matters of record. Eighty samples were examined, and nine seizures, totaling 2,326 cases, were made. In addition to this work import shipments of canned blueberries were inspected, comprising 1,184 boxes.

The peach crop is an important agricultural asset of the Southeastern States. The annual production of Georgia alone is estimated at 6,000,000 bushels. During the season of 1929, much injury to peaches in that section resulted from an infestation by the plum curculio, a beetle which attacks fruit.

Action was instituted by the administration to determine whether any of the damaged fruit formed any part of the canned product shipped in interstate commerce. Thirty-five official samples (564 cans) were collected and examined microscopically, the work extending over a period of about four weeks. As a result of this work libels were issued and seizures of approximately 80,000 cans of

unpeeled pie peaches consummated. This quantity represents only a small percentage of the total peach crop of the South, but it emphasizes the necessity for the constant surveillance of commercial foods exercised by the administration.

The administration's activities in controlling commerce in insect-infested fruit have not been confined to figs, blueberries, and peaches. Raspberries and Logan blackberries attacked by a beetle, moldy and decayed prunes, wormy cherries, wormy and moldy nuts are all subjects which have received careful attention from the administration and occupied much of the time of the force, especially in the field stations.

DECOMPOSED FISH

A problem which has been a source of concern for many years and which is illustrative of the second class of violations, is the canning of partially decomposed salmon. That the continuous control which has been maintained has resulted in a marvelous improvement in the quality of salmon marketed is evidenced by the fact that during the past year 1,801 lots, totaling 3,664,905 cases, were examined and only 3 prosecutions were recommended and 12 seizures consummated.

Another fish product, however, has caused a degree of concern second only to that previously occasioned by salmon. The canning of tuna fish is an important feature of the industrial activity of California. The rapid growth of the industry has been followed by a depletion of the fishing grounds adjacent to the canneries, and the fishing fleets have been driven to the necessity of going farther away for their cargoes. Naturally, longer distances for the boats to travel and lack of adequate icing facilities have resulted in an increased degree of spoilage, and about the end of 1929 it became apparent that a condition similar to the one which had existed in the salmon industry was developing in the tuna canneries. A vigorous campaign was begun, resulting in 24 seizures. The results were immediate and far-reaching. The California State Board of Health gave prompt and cordial support to administration officials, cooperated with them in mapping out methods of dealing with the situation, and extended its system of State inspection to insure better local control.

Although the passage of the Maine sardine inspection law more than a year ago permitted some relaxation of the vigilance which has been maintained in past years by the administration in respect to the sardines packed on the Maine coast, a sufficient amount of work has been done to keep the administration informed of the character of the product shipped. During the year 14 seizures were accomplished. The effective supervision now maintained by the Maine authorities is amply evidenced in the improved character of the present pack.

All samples of food suspected of being a menace to health or indicating decomposition, insect infestation, or the presence of filth are not only subjected to the scrutiny of the chemist but are also carefully analyzed by the bacteriologist. Some idea of the character and magnitude of the work may be obtained by consulting Table 3.

TABLE 3.—*Bacteriological examinations made from July 1, 1929, to June 30, 1930*

Class	Samples			Containers		
	Domestic	Import	Total	Domestic	Import	Total
Lactobacillus preparations.....	68	1	69	85	1	86
Water.....	158	45	203	577	213	790
Food poisoning.....			51			51
Sea foods.....	300	66	366	9,646	470	10,116
Fruits and vegetables.....	276	357	633	2,840	4,920	7,760
Total.....	802	469	1,322	13,148	5,604	18,803

FOOD VIOLATIONS INVOLVING ECONOMIC CHEATS

While unquestionably the welfare of the consumer requires that first attention be given offenses which affect the public health, or involve the distribution of decomposed or filthy foods, such forms of violation are fortunately rare as compared with those which result in economic cheats, damaging alike to consumers and ethical manufacturers. In the aggregate, therefore, the number of actions falling into this last class in any fiscal year is almost certain to exceed the number of offenses encountered in the other groups.

During the year seizures or prosecutions involving economic frauds in the food field included a material number of cases directed against short-weight or short-measure products. Water has been from time immemorial the most popular and inexpensive of adulterants. Excessive moisture is responsible for numerous actions involving butter and cheese, 246 regulatory actions involving butter having been instituted, and 11 involving cheese. During November more than 5,000 cases of canned tomatoes were seized at various points in the South because analysis showed them to have been adulterated with water. Reputable canners do not consider it necessary to add water to tomatoes in the canning process, and the sale of water at the price of canned tomatoes is a cheat of considerable magnitude.

Practically every year the administration is called upon to consider the problem of interstate commerce in frost-damaged oranges and grapefruit. In December, 1929, a severe freeze occurred in the citrus belt of the Rio Grande Valley of Texas, damaging about 25 per cent of the fruit on the trees. This was followed by a still heavier freeze in January of this year, resulting in even more serious damage.

The drying of the fruit as the result of a freeze does not take place immediately, and during the brief interval there is a tendency on the part of growers and packers to market all the fruit possible before the change in the quality becomes noticeable. Such fruit is practically worthless when it reaches the market, although externally it is of fairly satisfactory appearance. Its sale defrauds the consumer, ultimately discredits the producing region, and lowers the demand for its product in subsequent seasons. The work of the administration to be effective must be undertaken immediately after the freeze occurs. In the present instance the New Orleans station, in cooperation with the various State agencies, took immediate steps to control the situation. An inspector was sent to take charge of

the work, and spent 16 days in the valley examining fruit, instructing the corps of collaborators, and conferring with growers and packers. The freeze extended over an area of about 65 miles, and affected approximately 1,800 growers. The work was continued until the last car was loaded and offered for shipment.

About 75 cars of fruit were examined and a number of seizures made. The second day after the arrival of the administration inspectors a meeting of shippers was arranged at which the provisions of the law were explained as well as their practical application in the existing emergency. The results of the conference were most gratifying. The unanimous and hearty cooperation of the growers was extended to the administration and State representatives, and from then on numerous seizures were found unnecessary. All fruit examined and found frost damaged was voluntarily withdrawn from trade channels, and in cases where salvaging was impracticable it was buried in trenches or in some cases destroyed by incineration. About 35 cars of oranges and grapefruit were disposed of in this way. Practically all damaged fruit was destroyed, salvaging operations being confined to one plant which bottled juice from a small percentage of the grapefruit.

The results of the work were far-reaching and effective. The expense of numerous seizures was avoided, the shipment of worthless fruit was prevented, and a cordial spirit of cooperation was established with the growers in the Rio Grande Valley. A letter, addressed to the New Orleans station by the chamber of commerce of one of the important centers of the industry, expressed gratification at the outcome of the work and appreciation of its decided benefit to the industry.

Among other products against which action was directed because of violations constituting economic frauds were coffee adulterated with chickory and cereal, vegetable oils mixed with cheaper and less popular oils without appropriate label declaration, honey sophisticated with sugar sirup, so-called pure-fruit jams and jellies debased with undeclared pectin and sugar sirups, and stock feeds misrepresented as to their feeding value and composition.

ACTIONS ON DRUGS

Fraudulent representations regarding the curative properties of an illegal remedy may be justly regarded as a definite public-health menace, not only because such a product may harm the user, but also because its use may cause delay in resorting to rational methods of treatment. Fraudulent representations have been made at one time or another for a great variety of so-called patent or proprietary preparations. These include preparations advertised and sold for use in such dangerous diseases as tuberculosis, cancer, influenza, syphilis, rheumatism, and the like, and for a great variety of diseases of such vital organs as the liver, kidneys, stomach, and heart.

Every year numerous court actions have been instituted against falsely labeled preparations of this type, and the administration was active during the fiscal year in proceeding against them.

Two hundred and forty-nine seizures of falsely and fraudulently labeled proprietary medicines were effected. Of these, 135 were preparations falsely labeled in such ways as to state or imply they

were effective remedies for influenza. This was in continuation of the campaign against so-called influenza remedies reported during the previous year.

Among the most prominent of the fraudulent medicinal products are the so-called rheumatism cures. Many miscellaneous aches and pains are classed as rheumatism, and it is obviously impossible that any preparation could have a favorable effect on all of them. Administration inspectors are constantly on the alert to prevent interstate commerce in frauds of this character, and many samples of them are examined yearly. During the 23 years the food and drugs act has been in effect, over 600 cases of the so-called rheumatism cures have been terminated in the Federal courts. Several seizure actions against so-called rheumatism remedies were instituted last year.

Other seizure actions included stock remedies, blood tonics, kidney remedies, and treatments for venereal diseases, female complaints, stomach and digestive troubles, kidney and bladder disorders, and other ills.

Important pharmaceutical products relied upon in serious disease conditions are equally dangerous if they are not of the potency declared upon the label. Products that are too potent may be as dangerous as those that are too low in potency. They include tablets, pills, fluid extracts, tinctures, and the like, intended primarily for the use of physicians, or for sale through the drug stores on prescription. Active surveillance of the most essential pharmaceuticals has been maintained during the year. This work requires careful chemical and pharmacological analyses. Ninety-seven court actions involving adulterated or misbranded pharmaceutical preparations were brought during the year.

Previous annual reports have made reference to regulatory work directed against anesthetic ether. The chief difficulty encountered with this product is its tendency to develop aldehydes and peroxides. As an indication of the progressive improvement in the quality of the anesthetic ether now marketed, Table 4 shows the total number of cans of ether examined during the calendar years 1926 to 1929, inclusive, and the percentage of these found to be of non-U. S. P. quality. During the last fiscal year 39 consignments of ether which failed to meet the pharmacopeia standards were removed from the market by seizure.

TABLE 4.—*Anesthetic ether examined 1926 to 1929, inclusive*

Calendar year	Cans examined	Cans not of U. S. P. quality	
	Number	Number	Per cent
1926.....	470	162	34
1927.....	955	244	25
1928.....	1, 292	166	12
1929.....	3, 464	329	9

Because fluid extract of ginger is very largely used as a beverage and because its value as a drug is comparatively insignificant, regulation of the traffic in this product has been largely accomplished by the Bureau of Prohibition. This commodity, however, assumed great

importance when, in the early part of 1930, a large number of cases of paralysis was reported, resulting from the consumption as a beverage of a product made by a Boston firm, operating without an alcohol permit, and distributed as Jamaica ginger. Cooperative work with the prohibition authorities and State health officials was immediately undertaken, resulting in the seizure of 22 lots under the food and drugs act, in addition to the removal from the market of numerous consignments by other legal agencies.

SCIENTIFIC INVESTIGATIONS

The complicated nature of the problems encountered from year to year in control operations frequently makes necessary extended investigations upon the composition of certain foods and drugs. It becomes necessary to elaborate special methods of analysis and to determine not only normal food and drug constituents but also to ascertain what changes they undergo in the course of manufacture, storage, and aging.

Without question the most important contribution made by the administration's laboratories to the research field during the fiscal year was the extensive research on the pharmacology of ergot, to which reference was made in the last annual report, and which was carried to completion and published in a series of papers. The young scientist on the staff of the Food and Drug Administration who made this contribution to the pharmacology of ergot was awarded the Ebert prize, a gold medal presented each year by the American Pharmaceutical Association to the author of the best paper embracing original experimental investigation on any phase of the science of pharmacy.

This investigation was instituted because it had become evident in the course of the administration's regulatory operations on imported crude ergot and domestically shipped ergot preparations that comprehensive knowledge of the pharmacology of these products was lacking and that important and little-understood changes in the composition of the preparations occur in the course of storage and aging. On January 1, 1926, the tenth revision of the United States Pharmacopœia became effective. That revision contains definitions and standards for crude ergot and for fluid extract of ergot materially different from those given in the previous revision. Crude ergot, in addition to meeting certain definite physical standards, is required to comply with a biological test known as the cockscomb test. The fluid extracts of ergot must likewise meet this test. For purposes of comparison, a standard fluid extract of ergot is prescribed to be employed for the standardization of commercial fluid extracts and for the determination of the potency of the crude ergot. It was soon found that the prescribed standard is not a wholly stable product when made and stored under conditions prescribed in the pharmacopœia, that the fluid extracts made in accordance with the pharmacopœia requirements are even more unstable, and that a number of variables exist in the cockscomb test, rendering the results unreliable if analyses are made without proper precautions.

As a result of the investigation then undertaken, the administration has been able to prescribe a standardized cockscomb test. Expressed in terms of ergotamine, the active alkaloid of ergot, a standard extract should contain 0.5 milligram of ergotamine per cubic

centimeter. The cockscomb method as standardized in the administration's laboratories will determine the ergotamine content with an accuracy of ± 0.1 milligram. Definite recommendations have been made to the revision committee of the eleventh revision of the United States Pharmacopœia, designed to standardize the biological-assay method and insure a more permanent and reliable standard and fluid extract. Recommendations have also been made to manufacturers regarding methods of packaging and storing fluid extract of ergot which will minimize deterioration and largely prevent the unwitting sale by retail druggists of an article of lowered potency. It has been shown conclusively that the practice of shipping fluid extract of ergot of standard strength, in large containers, to be dispensed by the retailer in small portions from a stock bottle, is unsound and leads to marked deterioration through exposure to the oxidizing effect of the air while the partially filled containers remain on the druggist's shelf. Such partially filled containers are, of course, no longer subject to the jurisdiction of the food and drugs act, but their medicinal effectiveness is almost certain to be materially lessened. Manufacturers are already acting upon the recommendation of the administration and packaging interstate consignments of fluid extract of ergot of standard quality in 1-ounce containers, instead of in the materially larger packages heretofore distributed.

Industrial progress in perfecting chemical flavors imitating those of fruits has been rapid in recent years, and the detection of these synthetic flavors in fruit-type products is difficult and at times impossible, principally because of the small quantities used. The problem has been attacked along a new line involving the use of the optical immersion method employed by petrographers. Crystalline organic salts of the imitation-fruit ingredients are prepared and identified by determining their optical properties. A description of the preliminary work of this investigation has been prepared for publication and is entitled "Optical Properties of the Semicarbazones of Certain Aldehydes and Ketones."

Papers were published during the year describing methods for the determination in fruit and fruit products of tartaric acid and of citric acid. A paper was also published on the use of lead acetate in the determination of the acidity of fruit products. Procedures for the detection and determination of isocitric acid and inactive malic acid were formulated. The acid constituents of apricots, prunes, peaches, and strawberries were determined. In collaboration with the Bureau of Plant Industry an investigation was conducted in the Pacific Northwest on the packing of fruits in small containers by the so-called frozen-pack method.

A paper on the determination of cream of tartar and tartaric acid in tartrate baking powders has been approved for publication. Methods for the detection of excess shell and deficiency of milk solids in cacao products were tested and improved. The pentabrom-acetone method for determining citric acid in fruit products was adapted to the determination of this acid in coffee. Citric acid appears to be a normal ingredient of coffee, being present in quantities of as much as 1 per cent. The analyst thus has another means of arriving at the coffee content of mixtures other than by a caffeine determination.

An intensive investigation of the sanitary conditions prevailing in milk-drying plants has been begun, and 42 plants have already been

visited. Bacteriological studies were made of 52 samples of products and of the fluid milk delivered by 30 representative producers. Some of the plants inspected were found to be conducting operations under more or less insanitary conditions. The correlation between plant conditions and the bacterial content of the finished product was surprisingly good, and it is hoped that on the completion of the study now in progress, sufficient data will have been accumulated to formulate bacterial standards for powdered milk which will reflect the sanitary conditions prevailing at the place of manufacture.

In collaboration with the Association of Official Agricultural Chemists, among other things, work was done on the determination of starch in flour and of fat and moisture in dried milk; on the variations in moisture, ash, and protein, between samples consisting of the half loaf and the whole loaf of the same bread; on the estimation of the amount of butterfat in admixture with other fats and oils; on the determination of citral in orange and lemon extracts, and of total aldehydes in orange and lemon oils; on the determination of moisture and lead number, each by two different methods, in a large number of maple sirup samples; on the determination of the radioactivity of a clear solution, a soluble salt, and a refractory material; on a method long used by food-control laboratories for determining boric acid in waters; and on definitions for alfalfa meal, fish meal, etc., for the forthcoming revision of the Book of Methods.

FOOD STANDARDS

The food standards committee held two important meetings during the fiscal year.

At the October meeting revised definitions were adopted for mayonnaise salad dressing, for milk, for pasteurized milk, for skim milk, and for goat's and ewe's milk; the definition for coffee was revised to include cultivated coffees of the Robusta variety; and definitions for fruit juice, grape juice, and orange juice, were proposed and published for comment. Definitions for carbonated beverages of the soda-water class were discussed, and other topics receiving consideration were baking powder, ice cream, tomato juice, and sauerkraut juice.

During the spring meeting definitions were adopted for fruit juice, grape juice, and orange juice. On April 30, a public hearing was held upon the proposed definitions for whole-wheat flour, white flour, and bolted graham flour. The hearing was largely attended, and many pertinent suggestions were elicited from the public as well as from the milling trade. Final definitions were adopted for whole-wheat flour, entire-wheat flour, and graham flour, and the definition and standard for white flour was revised. During this meeting definitions were formulated for various soda-water beverages and beverage flavors. These have been published for comment and criticism.

CERTIFICATION OF COAL-TAR COLORS

The addition of coal-tar colors to foods to heighten their appeal to the esthetic sense is a growing practice. The manufacturer who makes use of such colors may guard against the selection of harmful dyes by consulting the list of certified colors issued by the adminis-

tration. The colors are certified and listed only after careful chemical analyses and physiological tests have shown them to be harmless.

The prominent feature of certification during 1929-30 was the placing of brilliant blue FCF among the permitted colors.

Table 5 indicates the colors certified by the department during the past five years.

TABLE 5.—Food colors certified, 1926-1930

Year	Straight dyes	Repacks	Mixtures	Batches	Number of firms	
					Total	New
	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Number</i>		
1926.....	311,434.5	32,234.00	304,040.22	1,075	38	14
1927.....	277,044.0	28,844.13	374,804.28	1,172	52	10
1928.....	273,282.8	15,279.00	310,137.40	1,206	52	5
1929.....	337,847.5	28,589.25	333,906.57	1,206	62	10
1930.....	318,849.5	36,646.00	330,873.46	1,272	55	1

Thirty-nine batches of straight dye and one batch of mixtures were rejected during the year.

INSECTICIDE ACT

The insecticide act is designed to protect farmers, fruit growers, and other users of insecticides and fungicides by such Federal regulation of labeling and manufacture as will insure truthful claims of quality and effectiveness, and the absence of any substance in insecticides and fungicides that might injure the plant to which applied.

The modified procedure for inspecting products, as outlined in the annual report for last year, which provides for basing regulatory operations primarily on information gained as the result of direct factory inspections, was continued with marked success, particularly in respect to giving prompt attention to objectionable labeling and correcting questionable manufacturing processes.

During the year, 1,616 insecticide and fungicide products were examined chemically, microscopically, or bacteriologically, and when necessary submitted to field tests. These are classified as follows:

Arsenate of calcium and boll-weevil preparations.....	111
Arsenate of lead.....	161
Bordeaux mixture and combinations of Bordeaux mixture with insecticides.....	75
Chlorinated lime and sodium hypochlorite preparation.....	16
Cyanide preparations.....	2
Dips for animals.....	48
Disinfectants, germicides, bactericides.....	153
Fly preparations for animals.....	84
Fish-oil and whale-oil preparations.....	12
Formaldehyde preparations.....	12
Insect preparations for household use.....	282
Lice and mite killers.....	59
Lime-sulphur solution and sulphur preparations.....	133
Pyrethrum and hellebore powders.....	27
Nicotine preparations.....	54
Paris green.....	39
Miscellaneous insecticide and fungicide preparations for agricultural use.....	202
Miscellaneous.....	146
Total.....	1,616

Twenty-six cases presenting alleged violations of the law were reported to the Attorney General to institute criminal prosecution or seizure proceedings. In 449 instances involving misbranding the labeling was voluntarily corrected by the manufacturers when the violations were called to their attention. In these cases the character of the misbranding was such that it was felt proper to refrain from further legal action after correction was obtained.

Calcium arsenate is produced on a large scale by 21 manufacturers. Over 25,000,000 pounds are manufactured annually, the major portion of which is shipped to the Southern States for use in the control of the cotton-boll weevil.

The insecticide act provides for the inspection of insecticides and fungicides offered for entry into the United States. Comparatively few new products were offered for importation during the year. The shipments inspected at the various ports were of products that for the most part had received attention in the past and were properly labeled. Samples from 44 consignments were found upon examination to be adulterated or misbranded, or both.

To safeguard cotton growers from inferior calcium arsenate, inspections were made during the year of the factories of all manufacturers of the product. Samples were obtained at the plants and from shipments in the possession of dealers and distributors located in the region infested by the cotton-boll weevil. It was found that 94 per cent of the samples examined were in compliance with the insecticide act, from the standpoint of labeling and composition, indicating that the manufacturers have so perfected their manufacturing operations that nearly all of the calcium arsenate now appearing on the market is up to a satisfactory standard, that is, contains a sufficient amount of total calcium arsenate to control effectively the weevil and does not contain an excess of water-soluble arsenic. The other 6 per cent of the samples were not in violation of the act from the standpoint of composition but had minor label defects.

The chemical work on insecticides and fungicides has been done in Washington and in field laboratories in New York, St. Louis, and San Francisco, the Chicago insecticide laboratory having been transferred to St. Louis. All bacteriological and microanalytical work has been done in Washington. Fungicide-testing stations are maintained in Oregon, New York, and New Jersey. An entomological testing station is in operation at Haddon Heights, N. J., in addition to the main entomological testing station at Silver Spring, Md. The South Carolina station, which was operated mainly for tests against the cotton-boll weevil, was discontinued for the present year.

As in the preceding year, tests of products used on horses, cattle, sheep, and hogs have been conducted, in collaboration with the Bureau of Animal Industry, mainly at the department's experimental farms at Bethesda and Beltsville, Md. In addition to the routine testing of official samples these stations have also been engaged in general studies to obtain information applicable to large classes of commercial insecticides and fungicides to which attention must be given in connection with the enforcement of the insecticide act. These investigations are the direct outgrowth of the needs of the regulatory work.

CHEMICAL TESTS

Work on the development of methods of analysis was continued, and copies of additional methods were prepared and furnished to all stations, covering molasses-calcium arsenate mixtures, chlorinated lime, sodium-hypochlorite solutions, chloramine-T, dichloramine-T, mixtures containing fluorine compounds, nonsoap mineral-oil emulsions, pine-oil emulsions, phenol, liquor cresolis compositus, saponified cresol solutions, emulsifying disinfectants, naphthalene, paradichlorobenzene, mercury ointments, and other mercury preparations.

A carbon disulphide extraction method for determining free sulphur in dusting materials has been worked out. A paper embodying the results of this study has been submitted to Industrial and Engineering Chemistry and will appear in an early issue.

Two methods for the determination of mercury in organic mercurials, such as those used in seed-treating preparations, have been carefully tested and found to give very satisfactory results. In one method the mercury is volatilized on to a gold crucible and weighed directly; in the other method the organic material is destroyed with 30 per cent hydrogen peroxide and the mercury precipitated and weighed as the sulphide.

Work on the determination of fluorine in fluorine compounds has been continued, particular attention having been given to modifications of the evolution method for determining total fluorine. A satisfactory procedure for this determination has not yet been evolved.

ENTOMOLOGICAL TESTS

During the year, 1,194 samples were submitted to the entomologist, and 142 samples were pending examination or consideration on July 1, 1929, making a total of 1,336 samples. Reports on efficacy claims for 1,287 of these preparations have been prepared, and 49 are still pending, since they require further work or consideration.

Although the laboratory has been seriously hampered in its work on preparations for use against household moths because of a shortage of these insects, apparently general throughout the country, considerable progress has been made in their control. Preliminary experiments have been carried out with paradichlorobenzene, to determine its rate of evaporation under different conditions, and the effect of the container on its evaporation. Tests on the commercial materials commonly recommended for moth proofing are being carried out. These require time, as some of the products are claimed to be effective for from one to five years and the truth of these statements can be checked only by actual tests.

In cooperation with the insecticide unit of the Bureau of Chemistry and Soils, an investigation has been made of the insecticidal value of the constituents of derris. Certain phases of the work with rotenone have been completed and will be submitted for publication in the near future. Some preliminary work has been done with nearly pure samples of Pyrethrins I and II, furnished by the insecticide unit.

As a result of the investigation of pyrethrum flowers from various sources, harvested at various degrees of maturity, it has been shown that neither of these factors can be accepted as giving an accurate

criterion of the efficacy of the product against insects. There may be more difference in efficacy between two samples of the same commercial grade of flowers than between two samples of different commercial grades. The results show, however, that the greatest activity lies in the achenes (fruit), and it would appear that the most economical time to harvest the flowers would be when they are fully ripened. The results of this investigation are given in Technical Bulletin No. 198, entitled "Relative Insecticidal Value of Commercial Grades of Pyrethrum."

FUNGICIDAL TESTS

The usual routine tests necessary to judge specific recommendations on the labels of fungicides were conducted. The work included tests against scab, bitter rot, fruit spot, fire blight, anthracnose, perennial canker, and mildew on apples, leaf spot and brown rot on cherries, peach brown rot, grape black rot, potato blight, prune brown rot, celery blight, strawberry leaf rust, and many other plant diseases.

Studies of the adhesiveness of various types of Bordeaux mixture and other copper fungicides, both sprays and dusts, as used against apple-tree anthracnose in Oregon, have been continued. In general, a correlation is shown between the adhesiveness and disease control.

In New York State extensive studies have been made of the problem of Bordeaux injury on certain varieties of sour cherries. A series of experiments on bitter rot of apples shows quite conclusively that the dust fungicides now available are not effective against this disease when applications are made according to the regular spray schedule. There is an indication that fair control may be obtained from some dusts by more frequent applications. The tests on bitter rot have also shown marked differences in results from various types of copper sprays, both as to control and foliage and fruit injury. They show quite clearly that the requirements for safe and efficient control of this disease are very exacting and that some commercial Bordeaux mixtures are unsafe and unfit for such purpose.

In New Jersey, New York, and Oregon a special investigation of various types of dusts is being made to determine the limitations of their use for the control of apple scab under varying climatic conditions. It is evident now that there are limitations; that the schedule of applications to insure satisfactory control must differ from that commonly followed where spraying is done.

VETERINARY TESTS

Labels were reviewed and reports made on 664 samples of products offered for sale for use on livestock. Nineteen of the products were subject to actual tests on animals, some of the tests extending to as many as 25 animals over a period of three months. Two mimeographed leaflets, entitled "Labeling Fly Sprays for Animals" and "Labeling Coal Tar Creosote Dips for Mange or Scabies of Animals," were issued to aid manufacturers in bringing their labeling into conformity with the law.

Experiments have been conducted on the effect of glycerin when used against sarcoptic mange of dogs and of paradichlorobenzene against sucking lice of swine. Neither of these preparations was found effective for the purpose named.

BACTERIOLOGICAL TESTS

Four hundred and thirty-two preparations were the subject of bacteriological investigation.

To aid manufacturers of sodium hypochlorite solutions in making their labels conform to the law a mimeographed leaflet, entitled "Labeling of Sodium Hypochlorite Solutions Recommended for Use as Disinfectants," was issued.

In order to gauge the usefulness of the *Bacillus typhosus* coefficient of coal-tar disinfectants in interpreting the practical value of these preparations against other organisms a large quantity of data has been collected and compared. Other problems on which preliminary work has been done are the following: (1) A study of the practical value of formaldehyde fumigation and the dosage required for practical fumigation work; (2) the determination of the bactericidal value of various pure chemicals; (3) the determination of standards of resistance for a *Streptococcus hemolyticus* used in phenol coefficient testing; (4) a study of the resistance of spores to chemicals with a view to establishing a standard of resistance.

A cooperative study has been carried out on a comparison of the Rideal-Walker modified test and the hygienic laboratory test for determining the phenol coefficient of four representative phenolic disinfectants. This has been reported before the Society of American Bacteriologists and the laboratory section of the American Public Health Association.

CAUSTIC POISON ACT

The Federal caustic poison act, passed in 1927, requires that certain caustic or corrosive substances and preparations containing them shall be labeled in a manner to convey knowledge of their dangerous character. It provides, in general, that these substances, when in packages suitable for household use, shall bear conspicuous and easily legible labels stating the common name of the substance; the name and place of business of the manufacturer, packer, seller, or distributor; the word "poison" in letters of the size and style specified in the law; and antidotal treatments for use in cases of accidental personal injury.

The survey of manufacturers of products coming within the scope of the law, which was carried on during the preceding fiscal year, was continued, with the result that the premises of 210 additional manufacturers of caustic or corrosive poisons were inspected. Nine hundred and twenty-five firms are now known to be manufacturing products subject to the caustic poison act. Proper steps have been taken to bring about appropriate modifications of the labels of these manufacturers in order to bring them into conformity with the law.

During the year much time was devoted to the correction of labels for carbolic acid and preparations containing this substance. The product is subject to regulatory control under the provisions of not only the caustic poison act but also the insecticide act and the food and drugs act. The survey of the establishments of manufacturers and distributors of the product indicated that many labels were defective under one or more of the laws named. Appropriate action has been initiated to bring them into compliance with the law.

Examination, under the insecticide and caustic poison acts, of coal-tar disinfectant preparations marketed by 48 manufacturers and distributors revealed the presence of carbolic acid in a concentration of 5 per cent or more, making it necessary that the labels bear the markings required by the caustic poison act.

A paper, *The Determination of Phenol in the Presence of Salicylates*, mentioned in last year's report, was published in the October number of *Industrial and Engineering Chemistry*, and another, *Aromatic Sulphuric Acid*, appeared in the *Journal of the American Pharmaceutical Association*. The study of the Chapin method for phenol and the Chapin method, as modified by Smith and Hamilton, has been continued and very satisfactory results have been obtained.

IMPORT MILK ACT

The fiscal year ended June 30, 1930, marked the second complete year of active enforcement of the Federal import milk act, and the results achieved justify the statement that the quality of imported milk and cream has improved, and from the public-health standpoint these important food commodities are equal to the best product of domestic origin. Experience gained during the previous year has developed a higher efficiency and standardization of inspection methods on the part of the administration's field forces, and also on the part of representatives of the Canadian Department of Agriculture and provincial officials, who made assiduous efforts to improve the quality and the sanitary conditions surrounding the production of Canadian milk and cream seeking entry into United States markets. As is indicated in the report for the preceding year, practically all of the foreign milk and cream coming into the United States is produced in the Provinces of Quebec and Ontario, Canada. Shipments from other Provinces in Canada and also from Mexico were entered, but these were quite negligible in amount.

The imported milk and cream supply from Canada came from a widely distributed territory, nearly 800 miles in length, extending from St. Thomas, Ontario, to Megantic, Quebec. Bacterial examination was made of the shipments of milk and cream coming into the United States. During the year 5,748 samples were examined. Of these, 369, or 6.4 per cent, showed an excessive bacterial count. One hundred and eight permits were suspended during the year. Forty-two permits were reinstated. Citations to hearing were issued on 134 samples. Letters of warning were issued on the basis of 221 samples. In all 8,690 subdivisions of the samples were examined. Of these, 5,588 consisted of raw milk, 519 of pasteurized milk, 16 of raw cream, and 2,567 of pasteurized cream. The inspection work included 584 plant inspections and 4,127 dairy farms. Milk and cream from 449 dairy farms were embargoed. After making proper corrections of unfavorable conditions reported, 153 dairy farms were released from embargo, and 334 permits were renewed.

Compliance with the labeling or tagging requirements has improved to such an extent that violations of this section of the law now rarely occur. Violations of the temperature requirement are only occasionally encountered. During the past year it has been possible to sample more frequently the importations at all ports, and, as a result of this improved surveillance, the compliance with bacterial

standards has come to be more nearly complete than during the previous year.

Because of better organization it was possible to inspect a much greater number of farms last year than previously. This has resulted in a very marked improvement of sanitary conditions on inspected farms and especially in improvement of methods of cleaning dairy utensils and cooling milk. The average score of farm producing for exportation to the United States has been rising steadily during the past year, and many permittee plants have installed better equipment and otherwise improved their factories.

During the first year's operation farm inspections disclosed the usual prevalence of garget or diseased condition of udders of cows furnishing the milk supply. This question was given attention during the last year by both the Canadian and United States inspection forces, and warnings were issued to the dairymen that cows with diseased udders would be barred from herds producing for exportation to the United States. On October 21, 1929, or about the time that applications were being received for renewal inspections for 1929-30, the veterinary director general of Canada issued an order excluding from the producing herds all animals which were suffering or had suffered from diseased-udder conditions. From previous physical examination records it was known that there were at least 3,000 animals with diseased udders producing for export. As a result of this exclusion order, operating at the time of inspections for renewals, the past year has seen the elimination of all cows with diseased udders.

The immediate result has been a very marked improvement in the quality and flavor of the milk received at pasteurizing plants and the gradual acceptance on the part of the milk producer of the principle that only cows with healthy udders are fit for milk production. It is believed that this step is one of the most progressive moves that has been made in improving the quality of imported milk. It is a step in inspection control which is now being copied by various State and city control authorities in the United States as well as in many of the local supplies of near-by Canadian municipalities.

As a means of maintaining a disease-free milk supply, there has been installed during the past year a system of inspection and control whereby samples are taken from the milk brought by each producer to a permittee plant. This milk is then subjected to the direct microscopic examination known as Breed-Brew count. By this means the bacteriologist is able to determine which producer is bringing in milk having a high bacterial count and also to point out to the inspector those producers bringing in milk that indicates diseased udders in their milking herd. With this information, the inspector is able to trace the probable cause for the high count and examine the herd for the presence of diseased-udder conditions.

Experience has shown the direct correlation between the bacteriological indications and the findings of the veterinarian upon examination of the producer's herd and inspection of his dairy premises and utensils. This careful system of inspection has been one of the most efficient methods yet found to improve the quality of milk and secure strict compliance with the provisions of the import milk act.

TEA ACT

The Federal tea act prohibits the importation into the United States of tea that fails to meet the Government standards of quality, purity, and fitness for consumption. Every shipment of tea offered for entry is examined in the tea laboratories at New York, Boston, San Francisco, Seattle, and Honolulu.

The quantity of tea offered for importation during the fiscal year 1930 was 84,732,677 pounds, or 8,860,587 pounds less than the 93,593,-264 pounds imported during the preceding year. In fact, this was the smallest quantity imported during any year since 1921, when the importations dropped to less than 72,000,000 pounds. Of the importations during 1930, 207,884 pounds (0.245 per cent) were rejected. Nearly all the rejections were due to failure to meet the standards of quality.

The decrease in importations was chiefly in teas from China, Japan, and Formosa. There was little change in the quantities of tea from Ceylon, India, Java, and Sumatra.

There was a slight increase in the quantity of tea brought in through the port of Boston, but a decrease in quantity at New York, San Francisco, Seattle, and Honolulu.

TABLE 6.—Kinds and quantities of tea passed and rejected during fiscal year ended June 30, 1930

Variety and station where examined	Quantity examined	Quantity passed	Quantity rejected for—	
			Quality	Purity
	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>
Formosa Oolong.....	6, 217, 370	6, 216, 650	270	-----
Congou.....	2, 361, 876	2, 361, 803	73	-----
India.....	19, 505, 034	19, 463, 862	41, 172	-----
Ceylon.....	27, 925, 213	27, 854, 340	70, 873	-----
Blended Ceylon and India.....	531, 882	531, 882	-----	-----
Java.....	7, 049, 160	7, 028, 380	20, 780	-----
Sumatra.....	199, 537	199, 537	-----	-----
Ceylon Green.....	491, 040	490, 680	-----	360
Ping Suey Green.....	3, 206, 112	3, 206, 112	-----	-----
Country Green.....	582, 526	582, 526	-----	-----
Japan.....	14, 495, 334	14, 491, 558	3, 776	-----
Japan Dust.....	1, 237, 132	1, 237, 132	-----	-----
Capers.....	975	975	-----	-----
Scented Orange Pekoe.....	15, 908	15, 908	-----	-----
Flowery Pekoe.....	3, 349	3, 349	-----	-----
Flowery Orange Pekoe.....	1, 317	1, 317	-----	-----
Scented Canton.....	495, 242	446, 550	48, 692	-----
Canton Oolong.....	298, 520	277, 148	21, 372	-----
Jasmine.....	60, 104	60, 038	66	-----
Formosa Black.....	27, 107	27, 107	-----	-----
African.....	12, 989	12, 989	-----	-----
Mixed origin.....	14, 950	14, 950	-----	-----
Total.....	84, 732, 677	84, 524, 793	207, 074	360
Boston.....	18, 368, 407	18, 366, 287	2, 120	-----
New York.....	48, 314, 257	48, 177, 670	136, 227	360
Honolulu.....	341, 245	341, 172	73	-----
Seattle.....	9, 097, 228	9, 093, 777	3, 451	-----
San Francisco.....	8, 611, 540	8, 545, 887	65, 653	-----
Total.....	84, 732, 677	84, 524, 793	207, 524	360

TABLE 7.—*Teas examined and rejected, 1916 to 1930*

Year	Quantity examined	Quantity	Re-jected ¹	Year	Quantity examined	Quantity	Re-jected. ¹
	<i>Pounds</i>	<i>Pounds</i>	<i>Per cent</i>		<i>Pounds</i>	<i>Pounds</i>	<i>Per cent</i>
1916.....	109, 536, 526	1, 768, 573	1. 614	1924.....	104, 492, 743	63, 159	0. 06
1917.....	105, 981, 158	954, 425	. 9	1925.....	92, 925, 470	84, 137	. 09
1918.....	148, 684, 384	2, 354, 277	1. 58	1926.....	98, 551, 814	457, 537	. 464
1919.....	113, 338, 535	1, 420, 568	1. 25	1927.....	97, 595, 579	100, 708	. 103
1920.....	96, 862, 858	145, 246	. 15	1928.....	91, 105, 613	57, 121	. 062
1921.....	71, 851, 847	350, 597	. 49	1929.....	93, 593, 264	115, 084	. 123
1922.....	87, 398, 221	1, 620, 162	1. 85	1930.....	84, 732, 677	207, 884	. 245
1923.....	96, 267, 920	277, 104	. 29				

¹ The rejections are those made by the tea examiners, not the final rejections made by the United States Board of Tea Appeals.

NAVAL STORES ACT

The naval stores act provides that all rosin and turpentine shipped in interstate or foreign commerce shall be sold under standards established by the act and authorizes Government inspection and grading of naval stores at cost upon the request of any interested person. Suitable penalties for violations of the act are provided.

Under the service features of the act, 197,216 barrels of rosin were classified and graded. Of these, 196,264 barrels were graded for producers at stills in the southern producing sections and 952 barrels were graded for distributors and consumers in the North and East. Six hundred and eighty-six United States rosin classification and grade certificates were issued.

Practically all rosin made in Texas, Louisiana, and Mississippi, a large part of that made in Alabama, and also a part of the Georgia production is graded by Federal naval-stores inspectors. The increase in the number of producers in Georgia requesting Government grading made it necessary to station an inspector at Waycross, Ga., at the beginning of the 1930 naval-stores season. Forty-three producers have taken advantage of the opportunity of having their rosin graded at the still by Government inspectors.

The returns to the Treasury during the fiscal year for work done upon request under the service features of the act amounted to \$13,956.20.

The analysis of numerous samples of turpentine and thinners collected from interstate shipments shows a general observance of the requirements of the law. The samples included gum spirits of turpentine, steam-distilled wood turpentine, destructively distilled wood turpentine, sulphate wood turpentine, and mineral thinner.

A case was brought to light of what appears to have been a deliberate attempt to furnish mineral oil on an order for pure gum spirits of turpentine under conditions indicating gross fraud. A similar case was reported last year. Both cases are now pending in court. Several cases in which wood rosin appears to have been deliberately furnished foreign buyers for gum rosin are under investigation with a view to prosecution.

A prosecution based on the charge that correct grade marks on rosin barrels had been removed and higher grade marks substituted was successfully maintained, the court imposing a fine on the offender. A similar case against the same shipper was terminated during the previous fiscal year.

Factory inspections to the number of 38 were made at the plants of dealers and distributors of naval stores products.

During the year no new standards for turpentine were promulgated nor any modifications made of the existing standards for turpentine and rosin. Research work was continued to develop fundamental knowledge on the color composition of rosin, for the purpose of later improving the existing standards.

Progress has been decidedly encouraging. A simple instrument, suitable for use in the field, has been devised and built, which will reduce to a very narrow margin the normal error incident to grading. It has also been found that the standards originally prepared, on the basis of their visual color, are theoretically and scientifically sound as permanent, reliable standards for the grading of rosin.

Another interesting development has been the discovery of a possible method for eliminating the dullness of the standard, which has given some concern since well-made rosin is often more brilliant than the standards themselves. It is probable that further effort in the way of manufacturing glass of higher brilliancy may not be necessary.

COLLABORATION WITH OTHER BRANCHES OF THE SERVICE

Collaboration with other departments of the Government continues to demand much attention from administration analysts.

Of outstanding importance during the year was the assistance given the Post Office Department in its efforts to purge the mails of such contraband materials as fake medicines, cure-alls, and poisons, with which various promoters flood the country. Approximately 130 such cases were handled in 1929. Not only are all the samples submitted to chemical examination, but the analytical figures are carefully scrutinized and interpreted, and all therapeutic claims are considered and judged by medical experts. Each case is fully discussed from chemical and medicinal standpoints, after which it goes to the Post Office Department for action.

Of 36 cases prepared and disposed of, fraud orders were issued on 12, in 2 instances penitentiary sentences with heavy fines were imposed, 3 grand jury indictments were issued, 2 prosecutions were abandoned because of insufficient evidence, and 17 of the concerns discontinued business. Of the remaining cases, 60 are pending and 30 are still under active investigation.

For outside departments of the Government other than the Post Office Department, 3,909 samples were examined. Of these, 2,356 were for the Veterans' Bureau, 257 for the General Supply Committee, 561 for the Department of Justice, and the remainder, 735, for various other departments.

PUBLICATIONS

The publications issued included, besides the annual report, 825 notices of judgment under the food and drugs act, 25 under the insecticide act, and 2 under the naval stores act. In addition, 5 circulars were printed, 3 service and regulatory announcements, 1 index to notices of judgment, 81 journal articles, and 1 bulletin. Four articles were contributed to the 1930 Yearbook.

REPORT OF THE FORESTER

UNITED STATES DEPARTMENT OF AGRICULTURE,
FOREST SERVICE,
Washington, D. C., September 25, 1930.

SIR: I transmit herewith the report of the Forest Service for the fiscal year ended June 30, 1930.

Respectfully,

ROBERT Y. STUART, *Forester.*

HON. ARTHUR M. HYDE,
Secretary of Agriculture.

THE FEDERAL FOREST POLICY

A Federal policy of forestry has been developing for almost 60 years. It has been built up by successive legislative enactments and the resulting activities. It is not a specific and limited program, but rather is the gradual unfolding of a national purpose.

That the American people are in favor of forest conservation as a public policy admits of no dispute. Extensive further forest destruction is held undesirable and injurious to the public welfare, and there is strong popular desire not only to have the present forests protected and maintained but also to have forests restored where man has removed them without subsequently putting the land to other use. The steady progress of legislation, State and Federal, decade after decade, and the growing public function in the field of forestry witness to this.

The Federal forest policy expresses the conviction of the people of this country that public action is necessary to insure the perpetuation and wise use of the forest resource and that the Nation through the Federal Government can best undertake certain portions of the task. The policy does not seek narrowly or merely to insure future wood supplies, nor merely to protect water resources, nor merely to obtain the indirect benefits and intangible satisfactions that forested areas provide. It is a policy based on a broad and deep-seated belief that if the forests are allowed to vanish the national welfare will suffer. It recognizes that forest preservation must be based on forest usefulness, but for the satisfaction of varied human needs.

This purpose of forest perpetuation as a public end gave strength to the early national-park movement, which in its initial stages made no functional differentiation between national parks and national forests. It had much to do with the attempt to bring about

forest establishment in the treeless regions through the timber culture act of 1873—a false first start in the field of Federal forest policy; and it had a large part in bringing about, upon the repeal of the timber culture act in 1891, the provision of law authorizing the President to create forest reserves.

For more than a decade previously the forest conservationists had been urging that all the public-domain timberlands should be reserved and placed under permanent administration. The law of 1891 made possible some progress toward this goal, although for a number of years there was no certainty that a permanent accomplishment of substantial proportions would follow. The law of 1897 established guiding principles that afforded a basis for eventually orienting and developing along permanent lines the national forest administrative policy. But the public purpose that finds its expression in the present Federal forest policy is of much broader scope than is represented by the national forest enterprise, great as that has become. It is a purpose which takes in not merely the minor fraction of the forests of the United States now owned or to be owned by the Federal Government, but all the forests of the United States.

The aim of the Federal forest policy is to bring about the highest use of the forest as one of the country's great basic resources. It recognizes that there exists at the present time a serious maladjustment of use to the character of the resource. In consequence of this maladjustment, which is partly an inheritance from an earlier stage of our national economic life, the forest is customarily used as a wasting resource. Men draw upon it to supply their needs without provision for its perpetuation and without care for its welfare. Progressive deterioration is the result; and this is a cause of community and regional loss, sometimes to the point of impoverishment. For this whole condition of maladjustment and unskillful, careless, or consciously destructive treatment of the forest the Federal forest policy is endeavoring to find correctives.

One of the most essential requirements for the effective application of forestry, either by public or by private owners, is adequate scientific and technical knowledge of the resource and of the best ways to handle it. Only technical foresters realize how enormous is the task of building up the knowledge on which sound practices and efficient use of our immensely complex and varied forest resource must rest. It is a task comparable in many ways with that of building up the whole body of agricultural knowledge on which rests successful and profitable farming in all parts of the country. The accumulation and dissemination of illuminative knowledge regarding forestry has been a Federal policy ever since 1876, when Congress appropriated \$2,000 to begin forest investigations in the Department of Agriculture. In the last few years provision for forest research by the Forest Service has been on a much broader scale than ever before.

The summary of the work done last year, which is given in the latter part of this report, shows something of its varied character, extensiveness, and practical value. Even so, in comparison with the urgent need for better knowledge the work is still inadequate. The Federal Government should assume the principal burden of obtaining the body of detailed and scientific knowledge which systematic

research must provide if the forests of the United States are to be put to their best use and perpetuated through wise and skillful handling. No other agency can be expected to do it, and the interest served is the national interest. A Federal forest policy shaped to meet fully the needs of the country would necessitate a very substantial expansion of the present forest research activities of the Government.

Another corrective which the Federal forest policy aims to apply is the organization of joint effort by the National Government and the States to facilitate private forestry. To bring about organized and efficient protection and constructive management of the forests of the whole country is of manifest and primary importance. A Federal policy of cooperation with the States is now in effect to these ends. The Nation offers to the States that will maintain protective systems against fire a contribution that by law may not exceed one-half the outlay. Under the same limitation, Federal contributions are also made to the States for the production and distribution of forest trees for planting and for advice to forest-land owners in the constructive management of their properties. More substantial and promising results, on the whole, have been attained in the forest protection cooperative effort than in forest replacement and forest perpetuation projects. It should be stated, however, that the total cooperative effort falls short of the needs of the situation. Forest protection and perpetuation on private forest lands is inadequately assured. Greater public and private effort is necessary.

The principal contribution of the Federal forest policy to bringing about the best use of the forest resources of the United States has been in connection with national-forest administration. The development of that policy, it is true, took place slowly for some years after the law of 1897 gave it definite direction, nor has it ever been extended to all the Federal lands to which it is in principle suited. With respect to the extent to which the President should make forest reserves the law of 1897 went no further than acceptance of what had already been done and continuance of authority for making more reservations; but it laid down very important governing principles regarding the lands that might be put into these reservations. Forest reservations might be established to "improve and protect the forest" or "for the purpose of securing favorable conditions of water flows" and to furnish "a continuous supply of timber for the use and necessities of citizens of the United States." These three authorized purposes afforded a touchstone for determining what character of public lands Congress designed to have included in the forests.

For the administration of the reserves the same act specified as the controlling objects "to regulate their occupancy and use and to preserve the forests thereon from destruction" and authorized the Secretary in charge to make such rules and regulations and establish such service as would insure the attainment of these ends. This authorization was the enabling act of national-forest administration and made possible the development of the main features of the national-forest policy of to-day. Its central purpose is to obtain from the resources the largest net total of public benefits. As this

purpose has, during the last 25 years, taken form and demonstrated its workability and public value, the resulting approval has been the chief factor in determining, up to the present time, the scope of the enterprise.

For years the whole policy of reservation hung in the balance. After the major part of the public domain timberlands had been placed in national forests Congress withdrew from the President authority to add further to the national forests in most of the western public-land States. After having increased very rapidly in area during most of the first decade of the century, the national forests experienced a decade of decline. During this second decade, too, considerable legislation was before Congress which if enacted would have crippled or abolished the whole national-forest system. On the other hand, the third decade of the century has been one of slowly increasing national-forest area. It may well be asked what national policy, if any, appears to be taking form with respect to the ultimate scope of the western national-forest enterprise.

That it is heartily approved by an overwhelming weight of western public sentiment is beyond question. Instead of wishing to curtail the national forests many westerners now desire their extension. Congress has passed a number of laws making specific additions sought by local communities. It has passed a general exchange act, as well as a long roll of specific exchange acts, which are bringing about substantial increases of the area under administration. It has authorized the Secretary of Agriculture to determine the location of public lands chiefly valuable for stream-flow protection or timber production, which can be economically administered as parts of national forests, with a view to the communication of his findings to Congress for such further action as Congress may deem fitting. The threat of large-scale abandonment of privately owned cut-over timberlands in some western localities is creating an additional demand for national-forest extension to give these abandoned lands a chance to reforest. Some timberland owners are inquiring regarding the possibility of donating their lands, subject to the privilege of cutting the timber later under forestry regulations, and local demands for the protection of watershed lands on the open public domain are creating new proposals for additions to the forests.

The time is auspicious for determining the scope of the western national-forest enterprise along more logical lines than have hitherto governed action. Twenty-five years of forest-resource administration by the Forest Service has afforded a demonstration of what can be done under public control to provide harmonized, correlated use of all the resources. The period of experiment and demonstration is over. It is possible to proceed functionally.

There still remains in the hands of the Federal Government a substantial acreage of public lands suitable for national-forest administration for the purposes specified in the law of 1897. There are many millions of acres of timberland in the interior of Alaska which are now almost without protection and seriously ravaged by great fires each year; there are some millions of acres of public-domain timberlands in the continental United States, the future of which is altogether uncertain; there are very extensive areas of

public lands requiring controlled use of the vegetative cover to prevent disastrous erosion, flood damage, and water waste. In addition, there are some millions of acres of privately owned timber land within or adjoining the national forests which should be handled as integral parts of the forests under the same management plan, through a blocking-up process now actually under way, though at an inadequate rate, by means of the land exchange authorizations; and there is the prospect of an accumulating area of idle cut-over lands which the owners will not wish to retain and which it would be very bad public policy to leave uncared for and nonproductive. Thus the scope of the general forest undertaking, which for the best interest of the West it will be necessary for some public agency to assume, begins to take on definiteness.

To some degree State forestry is entering the Western field. It should be encouraged and built up by all available means. However, if the Western States provide for the lands of their own that are suitable for forest administration, together with the lands that will revert to public ownership through tax forfeiture and those that adequate State policies of forestry will make it necessary for the States otherwise to acquire, it is improbable that they will wish to assume any heavier responsibilities. In short, the public lands forest problem is likely to remain a Federal problem. As a Federal problem, the best course for its solution is reasonably obvious. Let the governing principles laid down by Congress in the law of 1897 be applied. This would mean that wherever opportunity exists through national-forest administration to "improve and protect the forest," or to serve "the purpose of securing favorable conditions of waterflow," or to furnish "a continuous supply of timber for the use and necessities of citizens of the United States," public lands should not be disposed of, but should be added to the present area of the national forests and protected and administered accordingly.

The national forests in the eastern half of the country represent a Federal enterprise distinct from that in the Western States. The western enterprise is based on a policy of public-land reservations in the States where the Federal Government has always owned most of the virgin forest area. The eastern enterprise is based on a policy of recovering from private ownership such limited portions of the vast forest area as peculiarly call for public administration either for the sake of stream-flow regulation or (since the law of 1924 was passed) for timber production. This is true notwithstanding the fact that much of the land in the eastern national forests has come through the reservation of unappropriated remnants of the public domain in a few States.

Later on in this report the present program of acquisition for the upbuilding of the national-forest system of the East is outlined. Unlike the western system, it can not play a principal rôle in determining what the general forest conditions of the region shall be, save as the public forests may by example and education influence private forest policy. It can not, unless greatly expanded beyond its present scope, begin to take care of the interests of the East in water conservation through forest administration. Still less can it serve as a basis for public assurance of adequate future timber supplies for the

East. The eastern national-forest enterprise embodies a policy of limited Federal aid in and assumption of responsibility for protecting public interests that are in part State interests. It therefore can not be thought of as an adequate policy of public ownership for the East by itself. Failing complementary State policies, the field of public forest administration in the East will be left in large measure unoccupied unless the scope of the Federal enterprise is greatly enlarged.

PROGRESS IN STATE FORESTRY LEGISLATION

Although comparatively few of the State legislatures held sessions during the year, a number of States materially strengthened their forestry laws.

Porto Rico attempted to solve the forest-tax problem in a manner like that adopted by many of the States, through total exemption of land and timber after lands are classified as auxiliary insular forests. Kentucky substituted for its previous forest tax law, which had been declared unconstitutional, a leasing provision as a part of a new law for the establishment of forest reserves suited to the growth of timber and the propagation of wild-animal life. Lands for these reserves may also be acquired by purchase, escheat, or donation, and from delinquent-tax sales. Where lands are leased the term must be not less than 20 nor more than 100 years, and the rental may not exceed the amount of State, county, and school taxes on the land, which the owner continues to pay. When merchantable timber is taken from the leased lands one-half the stumpage value of the timber is paid to the lessor or his assigns and the other half goes into the State treasury and is credited to the forestry department.

New York amended her tax law by extending its application to all forest plantations instead of only to plantations made since January 1, 1921, and by providing that at no time shall the land be assessed at a higher valuation than that at the time when classification was or may be applied for. Also, the system of fixing the assessment was altered to make it conform to the system applied to lands generally.

Virginia provided that, subject to county approval, the department of conservation and development may set up forest, game, fish, and recreation reserves, comprising private forest lands or lands suited to the growth of timber, whose owners may offer them for this purpose. If such reserves are established, the department on assuming control is obliged to protect them, to stock them with game and fish, and to sell hunting, fishing, and recreational privileges. The land-owners obtain a postponement of the payment of taxes, with interest at 6 per cent, for not longer than 40 years; or alternatively they may receive annually one-half of the receipts from the sale of hunting, fishing, and recreation privileges, while paying all taxes annually. A temporary commission was created by Virginia to investigate forestry and forest taxation, to study the different methods of promoting forestry in the various States, including methods of taxing forests and waste lands, and to report their findings and recom-

mendations by January 1, 1932. Wisconsin amended its income tax law to allow the deduction from income of expenditures for planting or protecting a forest crop on lands registered under the forest crop law.

A number of States strengthened their forest-fire legislation. Kentucky provided that if owners of private forested lands fail to provide a sufficient patrol the State will furnish such protection at a charge of not to exceed 1 cent per acre per year. This provision does not apply to members of the various fire-protective associations now in existence. The penalties for unlawfully causing forest fires were made more severe, and mutilation or removal of posted notices of the State forest service was made a crime punishable by fine or imprisonment or both. Massachusetts gave the State forester power to order forests to be put under patrol by the town wardens at times of extreme drought with partial or entire State reimbursement of the cost, and also strengthened the restrictions upon setting fires in the open air. Mississippi made all county sheriffs reforestation wardens charged with duties that include enforcing the State reforestation laws and all rules and regulations of the State forestry commission and with authority to call on any citizen in a forest-protection area to assist in preventing or controlling forest fires.

An amendment to the New York State Constitution giving power to contract debts for the suppression of forest fires was adopted at the last general election by a vote of 3 to 1. The forest-fire laws of Rhode Island were amended in certain details. Virginia made refusal or failure to assist in fire fighting when summoned by fire wardens a misdemeanor, and regulated the building of fires in the open air, with penalties for failing to extinguish such fires.

Federal land acquisition for national-forest purposes was given a broader field in Wisconsin, which increased the maximum from 500,000 to 1,000,000 acres; in Georgia, which amended the enabling act to include the Okefenokee Swamp; and in Porto Rico, where the area of land that may be acquired is now unrestricted.

Kentucky authorized the governor to accept donated lands as State forest reserves, to be administered by the State forest service. Massachusetts increased the maximum acreage of lands to be acquired for State forests by 50,000 acres. The Department of Agriculture and Labor of Porto Rico was authorized to acquire lands by purchase or by the exercise of the power of eminent domain, to be used for forestry purposes as part of the insular forest reserve. The lands must be suitable for the production of wood products or for the conservation and regularization of the water currents or heads of rivers of the island, and the purchase price must not exceed \$20 per acre. Texas appropriated \$25,000 to purchase virgin State forest land lying in the longleaf-pine section of the State.

Virginia provided that tax-delinquent lands bid in by treasurers for the benefit of the State and certain waste and unappropriated lands of the Commonwealth chiefly valuable for forestry purposes may be set apart permanently as State forest land by proclamation of the governor. Wisconsin empowered the conservation commission to sell State lands and use the funds for blocking up State or county

forest lands; authorized the State or any county to exchange land for other lands, whether publicly or privately owned; increased the powers of county boards to acquire county forests; amended the county zoning law to cover areas to be used for agriculture, forestry, and recreation; and relieved counties taking tax deeds from the necessity of satisfying the tax claims of the State prior to sale of the land or, if the land is entered under the forest-crop law, until the forest crop is taken off.

Georgia required that instruction to teach the practical value of conserving and protecting forests shall be included in the curriculum of all public schools in the State. Massachusetts made it an offense to throw any lighted cigarette, cigar, match, ashes, or flaming substance from any vehicle, where it is likely to cause a forest fire.

New York extended the legislative reforestation commission for an additional year and gave the conservation commissioner authority to establish and maintain nurseries to produce trees for planting along highways, with a \$14,000 appropriation for initiating this work. An amendment to the State constitution was initiated the purpose of which is to assure adequate appropriations to make fully effective the State's enlarged reforestation program by providing \$19,000,000 over a period of 11 years, for the acquisition and reforestation of land, the management of forests thereon, and the establishment of forest-tree nurseries therefor. Two other constitutional amendments were initiated to permit the construction within the forest preserve of recreational facilities and State and county highways, with the necessary clearings.

WORK OF THE YEAR IN STATE COOPERATION

Table 1 shows the appropriations for cooperative work with States during the fiscal year 1930, in comparison with 1929 and 1931.

TABLE 1.—*Appropriations for State cooperation, 1929-1931*

Item	Amount appropriated for fiscal year—		
	1929	1930	1931
For the prevention and suppression of forest fires and for the forest taxation inquiry (secs. 1 to 3 of the Clarke-McNary law).....	\$1, 200, 000	\$1, 400, 000	\$1, 700, 000
For the distribution of forest planting stock to farmers (sec. 4 of the same law).....	75, 000	83, 000	93, 000
For farm forestry extension (sec. 5 of the law, administered by the Office of Cooperative Extension Work).....	60, 000	65, 000	65, 000

The results of the work are summarized below, except for the taxation study, which is covered on page 59. Table 2 shows in detail the Federal, State, and private funds disbursed by the States or expended under their supervision for the prevention and suppression of forest fires, and the Federal and State funds disbursed by the States for the production and distribution of planting stock.

TABLE 2.—Cooperative expenditures for fire protection and for the distribution of forest planting stock under the Clarke-McNary Act, fiscal year 1930

State	For fire protection				For the distribution of forest planting stock		
	Federal	State	Private agencies	Total	Federal	State	Total
Alabama.....	\$42,090.00	\$46,048.45	\$23,743.58	\$111,882.03	\$2,000.00	\$2,000.10	\$4,000.10
California.....	93,627.00	174,975.68	304,565.98	573,168.66	797.00	799.34	1,596.34
Colorado.....					2,000.00	2,049.76	4,049.76
Connecticut.....	11,262.00	56,375.27	6,726.59	74,363.86	2,000.00	4,091.47	6,091.47
Delaware.....	919.00	1,937.88		2,856.88	2,000.00	4,295.59	6,295.59
Florida.....	37,017.00	44,200.03	51,494.77	132,711.80	1,357.00	3,133.96	4,490.96
Georgia.....	40,664.00	18,274.51	30,954.83	89,893.34	2,000.00	2,496.77	4,496.77
Hawaii.....					2,600.00	16,326.98	18,926.98
Idaho.....	64,040.00	110,408.08	383,221.16	557,669.24	899.40	899.40	1,798.80
Illinois.....	2,179.00	6,798.59	1,030.00	10,007.59			
Indiana.....	1,700.00	2,264.32		3,964.32	2,000.00	8,028.73	10,028.73
Iowa.....					2,000.00	2,120.03	4,120.03
Kansas.....					2,000.00	3,528.86	5,528.86
Kentucky.....	12,719.15	12,719.15		25,438.30	2,000.00	2,714.08	4,714.08
Louisiana.....	41,530.00	66,594.63	25,100.78	133,225.41	1,442.67	1,442.68	2,885.35
Maine.....	52,965.00	157,890.53		210,855.53	757.44	757.43	1,514.87
Maryland.....	10,169.00	32,105.20	3,306.40	45,580.60	2,000.00	5,233.61	7,233.61
Massachusetts.....	29,417.00	100,567.59		129,984.59	2,175.00	7,115.35	9,290.35
Michigan.....	81,410.00	487,982.27		569,392.27	2,100.00	6,448.85	8,548.85
Minnesota.....	85,268.00	292,743.05	48,375.30	426,386.35			
Mississippi.....	9,596.43	29,500.00		39,096.43	326.15	326.16	652.31
Missouri.....	7,940.85	7,940.86		15,881.71	1,405.24	1,392.10	2,797.34
Montana.....	26,369.00	14,163.69	49,099.22	89,631.91	2,000.00	2,822.42	4,822.42
Nebraska.....					2,200.00	10,136.00	12,336.00
New Hampshire.....	17,132.00	41,722.38	7,189.81	66,044.19	2,100.00	3,720.00	5,820.00
New Jersey.....	20,442.00	33,546.67		53,988.67	2,300.00	14,564.00	16,864.00
New Mexico.....	581.00	5,423.00		6,004.00			
New York.....	65,201.00	296,551.09		361,752.09	6,000.00	124,845.43	130,845.43
North Carolina.....	44,757.00	63,870.64	9,877.96	118,505.60	2,000.00	2,606.04	4,606.04
North Dakota.....					2,100.00	5,220.11	7,320.11
Ohio.....	5,485.00	22,392.40		27,877.40	2,150.00	13,076.51	15,226.51
Oklahoma.....	14,429.00	10,052.41	12,014.00	36,495.41	2,000.00	4,440.81	6,440.81
Oregon.....	86,345.00	39,884.52	133,535.74	259,765.26	2,000.00	2,384.10	4,384.10
Pennsylvania.....	50,181.00	327,438.72		377,619.72	2,550.00	21,834.37	24,384.37
Porto Rico.....					2,225.00	16,805.79	19,030.79
Rhode Island.....	1,886.00	9,220.17		11,106.17			
South Carolina.....	18,196.43	8,631.53	9,729.09	36,557.05	2,000.00	2,536.60	4,536.60
South Dakota.....	375.00	5,229.00		5,604.00			
Tennessee.....	23,619.00	23,672.86	9,275.81	56,567.67	2,005.40	4,472.22	6,477.62
Texas.....	32,661.00	39,540.97	10,221.59	82,423.56			
Utah.....					1,300.00	1,300.00	2,600.00
Vermont.....	7,694.00	8,384.87	5,214.44	21,293.31	2,200.00	5,910.93	8,110.93
Virginia.....	32,814.00	40,628.53	8,780.12	82,222.65	2,000.00	4,382.79	6,382.79
Washington.....	93,479.00	106,136.98	52,915.05	252,531.03	1,934.90	1,934.90	3,869.80
West Virginia.....	22,733.00	25,141.78	10,632.87	58,507.65	699.55	699.56	1,399.11
Wisconsin.....	38,527.00	141,511.14		180,038.14	2,000.00	2,002.64	4,002.64
Wyoming.....					1,138.60	1,138.60	2,277.20
Administration and inspection.....	75,274.40			75,274.40	1,715.97		1,715.97
Total.....	1,302,694.26	2,912,469.44	1,197,005.09	5,412,168.79	80,479.32	322,035.07	402,514.39
Forest tax studies.....	64,159.98						
Unexpended balance.....	33,145.76				2,520.68		
Total appropriation.....	1,400,000.00				83,000.00		

In addition to the expenditures made to carry the specific cooperative projects shown in Table 2 a substantial sum was expended independently by private individuals and associations and by counties. The sum so reported for the calendar year 1929, the last year of record for this class of expenditure, was \$270,000. The actual sum was undoubtedly much larger.

COOPERATIVE PROTECTION OF STATE AND PRIVATE FOREST LANDS FROM FIRE

For the calendar year 1929 the area of forest or potential forest land under State and private ownership which was reported by the cooperating States as under some form of systematic protection from forest fires was approximately 224,000,000 acres. This is 54 per cent of the 417,000,000 acres of State and private forest land classified in 1930 as needing such protection. A gain of approximately 46,000,000 acres since 1925 in the area under protection evidences that progress is being made, but the gap of 193,000,000 acres between the area protected and that needing protection points out the problem which still remains. Of this still unprotected area 80 per cent, or 154,000,000 acres, lies in the Southeastern and Gulf States. With the Central States added the unprotected area becomes 180,000,000 acres, or 93 per cent of the total for the entire country. The situation constitutes a challenge to the South.

The greatly increased interest in forest conservation in that region promises well. It is being substantially enlarged by the educational work which the American Forestry Association has been carrying on with the States of Georgia, Florida, and Mississippi during the past two years. Another hopeful feature is the active interest of many timberland owners, manifested in \$202,855.40 contributed last year by private owners to the cooperative forest fire protection funds in the 17 Southeastern, Gulf, and Central States. There is, however, an outstanding failure on the part of many of these States to provide substantial State appropriations for the work.

With \$13,367,500 estimated as necessary to do a complete job and only \$6,069,000 spent in 1929 for this work, the need of much larger State, Federal, and private funds is manifest. Substantial increases in State appropriations would have far-reaching effects.

Revised estimates of the acreage of State and privately owned forest land needing protection from fire and of the cost of protection were completed during the year and are shown in Table 3.

TABLE 3.—*Area and cost estimates for protection of State and private forest land, 1930 revision*

State	Area of forest or potential forest land	Estimated cost of protection	State	Area of forest or potential forest land	Estimated cost of protection
	<i>Acres</i>	<i>Dollars</i>		<i>Acres</i>	<i>Dollars</i>
Maine.....	14,957,000	342,000	Oklahoma.....	12,388,000	165,000
New Hampshire.....	4,259,000	131,000	Arkansas.....	22,000,000	484,000
Vermont.....	3,375,000	57,000	Ohio.....	2,160,000	60,000
Massachusetts.....	3,300,000	169,000	Indiana.....	3,000,000	84,000
Rhode Island.....	280,000	17,000	Illinois.....	2,750,000	77,000
Connecticut.....	1,500,000	76,000	Kentucky.....	9,000,000	212,000
New York.....	11,689,000	378,000	Tennessee.....	10,430,000	245,000
New Jersey.....	1,906,000	128,000	Missouri.....	15,750,000	347,000
Pennsylvania.....	12,365,000	364,000	Michigan.....	18,596,000	662,000
Delaware.....	325,000	12,000	Wisconsin.....	13,187,000	390,000
Maryland.....	2,200,000	73,000	Minnesota.....	20,523,000	697,000
Virginia.....	14,005,000	397,000	South Dakota.....	79,000	4,500
West Virginia.....	9,251,000	312,000	Montana.....	4,854,000	190,000
North Carolina.....	20,568,000	632,000	Idaho.....	4,601,000	447,000
South Carolina.....	12,500,000	378,000	Washington.....	12,080,000	632,000
Georgia.....	23,100,000	775,000	Oregon.....	10,685,000	584,000
Florida.....	22,900,000	847,000	California.....	18,955,000	969,000
Alabama.....	22,386,000	573,000	New Mexico.....	1,800,000	26,000
Mississippi.....	19,500,000	563,000			
Louisiana.....	17,900,000	434,000			
Texas.....	15,657,000	434,000	Total.....	416,761,000	13,367,500

The totals are greater than those of previous estimates, as was to be expected, since many of the former State estimates had to be made before systematic work had been undertaken and were conservative. It is also true that in many States the area of forest and potential forest land has increased during the last decade, through the abandonment of submarginal farm lands. This does not mean, however, that the areas of forest land of present merchantable value have increased. The new estimates were used in determining the allotment of Federal funds to the States for cooperative fire protection for the fiscal year 1931.

In response to a request from the Governor of Arkansas a survey was made under the terms of section 1 of the Clarke-McNary law to determine means by which privately owned and State-owned forests in Arkansas could be adequately protected from forest fires. The results of this study will be published and distributed early in the fiscal year 1931 by the Arkansas Extension Service, which, with the Arkansas Forest Protective Association, constituted the principal local cooperators.

The total area reported as burned over in the calendar year 1929 on lands protected by the States or the Forest Service was 4,876,000 acres, as against 4,111,000 acres in 1928; and on unprotected areas, 41,354,000 acres, as against 39,431,000 acres in 1928. For unprotected areas the available data are too fragmentary and inexact to permit of more than rough estimates, though they are constantly growing better. Their roughness does not impair the essential significance of the fact that 89 per cent of the total area burned over was non-protected land. This is hopeful, provided rapid progress can be made in placing all the land under protection. Within protected units, 4,876,000 acres were reported as burned over, or 1.22 per cent of the land. The same percentage applied throughout would have made the area burned by all forest fires 7,196,000 acres, as against the estimated 46,230,000 acres.

COOPERATION WITH STATES IN TREE PLANTING

Farmers of the continental United States and the Territories of Hawaii and Porto Rico were supplied with more than 25,000,000 young forest trees from the nurseries of the States and Territories cooperating under section 4 of the Clarke-McNary law. This meant timber production initiated or restored on more than 25,000 acres of farm lands. Most of the cooperating States distributed more trees than in 1928, but in New York and Pennsylvania the number decreased by nearly 5,000,000, partly because these States were unprepared to furnish the desired quantities of certain kinds of trees which have recently become popular for planting. In addition, to secure greater success, especially when the planting is large, Pennsylvania now encourages spreading the work over several seasons rather than attempting to do it all in a single year. This has somewhat decreased the immediate demand for trees.

Material increases in the number of trees distributed from the various State nurseries in the South evidenced an awakening interest there in timber as a farm crop, while recognition of the value to farms of shelter belts and wood lots has resulted in constantly growing demands for planting stock in the Plains States.

Improvement of the Forest Service seed-extraction plant on the Chippewa National Forest in Minnesota will make possible the furnishing of all the Norway pine seed needed by the cooperating States at a moderate cost. The seed of other species native to the Lake States will also be furnished so far as the supplies will permit.

The addition during the year of the State of Utah increased the number of cooperating States and Territories to 41. The allotments and expenditures are shown in Table 2.

COOPERATION WITH STATES IN FARM FORESTRY EXTENSION

Federal cooperation in farm forestry, authorized under section 5 of the Clarke-McNary law, is conducted as a part of the extension program of the several State agricultural colleges, and is administered by the Extension Service of the Department of Agriculture with the cooperation of the Forest Service. The Federal appropriation of \$65,000 for the last fiscal year was used mostly for the employment of extension foresters.

Increased concrete results were due in part to an enlarged interest, which in turn can be traced to more effective methods of reaching farm owners. A much greater desire on the farms for improved forestry practices has sprung from realization that better woods practices contribute not only to meeting the farm timber needs but also to making the country home more livable and to the family income.

The work embraced such major projects as planting, improvement cutting, timber estimating, fire prevention, and 4-H Club work in forestry. In several States marketing, sawmill improvement, and maple-sirup production were included. The most popular work was forest planting. It was extended in some form in all the 33 States and 2 Territories having extension foresters, and was the principal project in 5 mid-Western States, where windbreaks and shelter belts are needed on most farms. Forest planting is also the greatest farm forestry need in Hawaii and Porto Rico.

Better forestry practices were adopted on 21,350 farms. Of 8,422 forest plantations established, 3,088 were for windbreaks. There were 4,870 woods-management or thinning projects and 949 project units for controlling white-pine blister rust. Forestry projects were completed by 3,852 4-H Club members, mostly boys. There were 320 forestry clubs, with 5,608 members, an increase of 39 per cent over the enrollment in the preceding year.

NATIONAL-FOREST ADMINISTRATION

The expenditures for national-forest administration, protection, improvement, reforestation, and extension are shown in detail on page 79, totaling \$23,435,272.95. This is exclusive of expenditures for administration of the Forest Service as a whole (i. e., general overhead).

The appropriations of Federal funds for the national-forest enterprise in the fiscal years 1929, 1930, and 1931 are shown in Table 4.

TABLE 4.—*Appropriations of Federal funds for the national-forest enterprise, 1929-1931*

Item	1929	1930	1931
General expenses of administration, protection, and improvement.....	\$7, 119, 673. 00	\$7, 527, 730. 00	\$7, 477, 230. 00
Specifically for—			
Fire control.....	1, 269, 996. 57	3, 450, 000. 00	150, 000. 00
Improvements, tree planting, land and resource surveys, and land adjustments.....	1, 005, 270. 00	1, 101, 050. 00	2, 955, 500. 00
Land acquisition.....	1, 005, 156. 60	2, 000, 000. 00	2, 000, 000. 00
Roads and trails (construction and maintenance) needed primarily for forest protection and development.....	3, 540, 511. 91	3, 625, 855. 89	3, 671, 023. 72
Highway construction and maintenance primarily to meet public needs, as a recognition of Federal responsibility created by ownership of untaxed lands.....	4, 500, 000. 00	4, 500, 000. 00	8, 000, 000. 00

The amounts shown in Table 4 for the first and third items of the 1930 column are greater than was reported last year, in consequence of augmenting appropriations. Two deficiency appropriations increased the first item by \$332,500, of which \$177,500 was for insect control and \$155,000 for emergency guards. The third item gained \$35,000 through a special appropriation for the improvement of the Oregon Caves on the Siskiyou National Forest.

The appropriations for the fiscal year 1931 under the same two items (the first and third) differed from those for 1930 in the following respects: On the one hand, the above-mentioned special appropriations for 1930 drop out. On the other hand, increases were made under both items for various purposes. Under the first item, increases totaling \$282,000 comprised \$188,500 for the employment of additional forest guards and the purchase of fire-control equipment; \$20,500 more for the administration of timber sales; \$25,000 for the control of tree-destroying insects and \$25,000 for the control of the white-pine blister rust; \$3,000 for the removal of trespassing horses on national-forest ranges; and \$20,000 for the administration of new purchase areas. Under the third item increases totaling \$1,889,450 comprised \$1,500,000 for the construction of protection roads and trails, \$331,000 for other protection improvements (including \$25,000 specifically for expenditure in the four southern California forests), \$15,000 for range improvements, \$9,000 for administrative improvements, \$7,000 for camp-ground improvements, \$15,000 for planting, and \$12,450 for timber surveys and grazing reconnaissance.

The fire-control appropriation for 1931 shown in Table 4 is the regular appropriation for fighting forest fires and for aerial fire control, which is the same as in 1930, whereas deficiency appropriations made in 1929 and 1930 are added to the regular appropriation for those years. Since the expenditures that will have to be made for fire suppression are unpredictable and vary greatly, Congress does not attempt to provide adequate funds in advance but supplements a small regular appropriation by deficiency appropriations after the work is done.

The amounts shown as appropriated under the two road items for the individual years do not include balances brought forward or which may be carried forward from appropriations of previous years. The sums actually available for expenditure in any year

often vary widely from the appropriations for the same year through carry-overs of unexpended portions of earlier appropriations.

THE NATIONAL-FOREST REGIONS

Ever since 1908 the western national forests have been divided, for administrative purposes, into six districts, each under a district forester. Subsequently there were added, as need arose, the Eastern district, the Alaska district, and, finally, on January 1, 1929, the Lakes States district. The wisdom of this form of organization made itself evident from the outset, and its value has grown with the years. There has been, on the whole, a steady outward movement of responsibilities from the Washington office to the district offices through a broader delegation of authority, as the district foresters, with their staffs, have proved their competence to assume weightier responsibilities.

The Forest Service has always had the determined purpose not to centralize, but, on the contrary, to give local officers as much opportunity to use initiative and exercise discretion as is reconcilable and consistent with safety and coordination. The district foresters have provided indispensable halfway stations between the individual forest organizations and the central executive authority, receiving general direction in policy matters, expert advice and assistance of the highest quality on their more serious technical problems, and supervision, exercised principally through field scrutiny of their administrative performance by the Forester and his staff. Only in matters of very exceptional importance, either because of the magnitude of the transaction involved or because a question of new policy or policy interpretation is raised, is reference to Washington for decision now necessary. The district foresters in turn have pressed further outward the exercise of initial responsibility as the forest supervisors have established their capacity to handle their local business and resources skillfully.

On May 1, 1929, the Secretary of Agriculture approved a change in the official designation of the nine districts, the district foresters, and other district officers of the Forest Service, by which region and regional supersede the term "district."

On March 1, 1930, C. J. Buck became regional forester for the sixth region, the previous incumbent, C. M. Granger, having been made head economist and director of the forest survey. The nine regions and regional foresters are:

Region 1: Northern Region. Montana, northeastern Washington, northern Idaho, northwestern South Dakota. Evan W. Kelley, regional forester in charge.

Region 2: Rocky Mountain Region. Colorado, most of Wyoming. South Dakota, Nebraska, western Oklahoma. Allen S. Peck, regional forester in charge.

Region 3: Southwestern Region. New Mexico, most of Arizona. Frank C. W. Pooler, regional forester in charge.

Region 4: Intermountain Region. Utah, southern Idaho, most of Nevada, northwestern Arizona, western Wyoming. R. H. Rutledge, regional forester in charge.

Region 5: California Region. California, southwestern Nevada. S. B. Show, regional forester in charge.

Region 6: North Pacific Region. Oregon, most of Washington. C. J. Buck, regional forester in charge.

Region 7: Eastern Region. Maine, New Hampshire, Vermont, Pennsylvania; all States south of the Potomac and Ohio and east of the Mississippi; Arkansas, Louisiana. J. C. Kircher, regional forester in charge.

Region 8: Alaska Region. Alaska. Charles H. Flory, regional forester in charge.

Region 9: Lake States Region. Ohio, Indiana, Illinois, Michigan, Wisconsin, Minnesota, Iowa, Missouri. Earl W. Tinker, regional forester in charge.

THE NATIONAL-FOREST PROPERTIES

The gross area of the national forests on June 30, 1930, was 183,975,930 acres, of which 23,885,113 acres was in ownerships other than that of the United States, making the net area 160,090,817 acres. During the year the gross area decreased 589,023 acres, but the net increased 340,297 acres.

Area recomputations, based on better surveys and land data, reduced the gross area by 25,378 acres. Otherwise the gross area changes were as listed in Table 5.

TABLE 5.—Additions to and eliminations from the gross area of the national forests made by acts of Congress, presidential proclamations, Executive orders, State land exchanges, other land exchanges, and departmental action under the act of March 1, 1911

National forest	State	Additions	Eliminations
		<i>Acres</i>	<i>Acres</i>
Arapaho.....	Colorado.....	¹ 640	
Ashley.....	Utah-Wyoming.....	² 13,785	
Bitterroot.....	Montana.....	¹ 160	
Black Hills.....	South Dakota-Wyoming.....	¹ 320	
Do.....	do.....	² 1,280	
Coronado.....	Arizona.....		³ 32,635
Crater.....	Oregon.....	¹ 1,317	
Custer.....	Montana-South Dakota.....	² 1,066	
Deschutes.....	Oregon.....	¹ 25,210	
Fishlake.....	Utah.....	³ 13,578	
Fremont.....	Oregon.....	⁴ 193,199	
Harney.....	South Dakota.....	¹ 149	
Do.....	do.....	² 1,347	
Helena.....	Montana.....	⁴ 800	
Kisatchie.....	Louisiana.....	⁵ 9,613	
Lolo.....	Montana.....	¹ 3,568	
Mount Hood.....	Oregon.....	¹ 3,382	
Nantahala.....	Georgia, North Carolina, Tennessee.....	² 122,966	
Olympic.....	Washington.....		⁶ 45,809
Pisgah.....	North Carolina-Tennessee.....		² 586,284
Plumas.....	California.....	¹ 1,081	
Routt.....	Colorado.....		² 401
Siuslaw.....	Oregon.....		⁶ 43,388
Snoqualmie.....	Washington.....		⁶ 1,902
Stanislaus.....	California.....	¹ 1,646	² 7,726
Tahoe.....	do.....	¹ 299	
Tongass.....	Alaska.....		³ 168
Tusayan.....	Arizona.....		⁴ 115,500
Wallowa.....	Oregon.....	¹ 2,199	
Wenatchee.....	Washington.....	¹ 1,798	
White Mountain.....	Maine-New Hampshire.....		² 130,912
Whitman.....	Oregon.....	¹ 1,677	
Total.....		401,080	964,725

¹ Made under land exchange laws.

² Made by presidential proclamation.

³ Made by Executive order.

⁴ Made by acts of Congress.

⁵ Departmental action under act of Mar. 1, 1911. (36 Stat. 961.)

⁶ Made by State land exchange.

The area eliminated from the Coronado National Forest is a part of the Fort Huachuca Military Reservation, which proved to be impracticable of administration as a national forest. The elimination from the Stanislaus National Forest was added to the Yosemite National Park, and that from the Tusayan National Forest was added to the Navajo Indian Reservation. The eliminations from the Pisgah and White Mountain National Forests were of lands found to be nonpurchasable under the acquisition laws, while the eliminations from the Olympic, Siuslaw, and Snoqualmie Forests were to permit selections by the States under land-exchange agreements. A number of small areas developed under special-use permits were eliminated from the Tongass Forest to permit their entry under the trades and manufacturing act as amended.

As the result of several laws permitting the acquisition of lands outside of national-forest boundaries through exchanges, 43,446 acres were added. Public-land additions by acts of Congress, Executive order, or presidential proclamation totaled 225,055 acres, and additions to eastern national forests of lands believed to be purchasable under the Weeks and Clarke-McNary laws aggregated 132,579 acres, of which, however, all but 9,613 acres must be acquired by purchase before possessing actual national-forest status.

In June the chairman of the Commission on the Conservation and Administration of the Public Domain requested the Forest Service to obtain and furnish to the commission data on public-domain lands believed to be chiefly valuable for timber production or stream-flow protection. At the close of the year this work was well under way.

LAND ACQUISITION THROUGH EXCHANGE

During the year the State of Michigan conveyed to the United States 14,420 acres of land situated within national-forest boundaries, receiving in exchange 14,393 acres of public land within existing or proposed State forests. A further exchange with the same State involving approximately 75,000 acres on both sides is under way. Progress was made in working out a further exchange with the State of South Dakota. In Colorado a national-forest area of approximately 80,000 acres suitable for administration as a State forest was designated and in process of appraisal at the close of the year, with a view to its exchange for an equal area of scattered State holdings in the forests. An exchange with the State of New Mexico still awaits a necessary constitutional amendment. The earlier exchanges with the States of Washington, Oregon, California, Idaho, and Montana gradually are being completed as selection lists are filed and approved.

Several bills to extend the provisions of the general exchange act to lands outside the national forests were introduced in Congress, but none was enacted and no new land-exchange legislation took place. During the calendar year 1929 reconveyance to the United States of 240,732 acres of private lands in exchange for 50,156 acres of national-forest land and \$643,837 worth of stumpage added a net 190,576 acres to the forests. The Secretary of Agriculture approved and referred to the Secretary of the Interior for further action 164 new cases, offering 237,356 acres of privately owned land in exchange for 117,416 acres of national-forest land and 114,829,000 board feet of national-forest stumpage. In all, to

December 31, 1929, 535 land-exchange cases have been consummated. They have brought the United States 780,452 acres of land, valued at \$3,312,983, in exchange for 236,146 acres of national-forest land, valued at \$1,289,088, and 587,587,000 board feet of national-forest stumpage, valued at \$1,664,515. Besides the net gain of 544,306 acres in national-forest area the volume of stumpage on the acquired lands is much greater than that surrendered. A much larger land-exchange business could have been done were it not for the fact that to avoid undue impairment of county incomes through lessened timber-sale receipts, of which 25 per cent goes to the counties, the value of stumpage employed for land-exchange purposes is usually not allowed to exceed 10 per cent of the receipts from timber sales.

Table 6 shows the progress and results of the land-exchange work to the close of the calendar year 1929.

TABLE 6.—*Land exchanges consummated to December 31, 1929*

State	Num- ber	Land conveyed to the United States		Selected land granted in exchange		Timber granted in exchange	
		Acres	Appraised value	Acres	Appraised value	Volume (thou- sand board feet)	Value
Arizona.....	18	130,691	\$233,168	8,342	\$15,906	79,336	\$198,611
Arkansas.....	2	27,288	47,089			5,752	46,020
California.....	57	106,249	1,020,045	10,333	316,726	142,604	504,373
Colorado.....	106	52,026	209,798	14,620	48,119	48,468	143,195
Florida.....	12	56,106	117,175	21,095	42,696	12,514	72,785
Idaho.....	48	41,656	125,091	10,621	51,499	8,281	54,351
Michigan.....	5	45,781	48,004	45,337	47,632		
Minnesota.....	12	1,829	9,887	26	16	1,386	6,113
Montana.....	58	84,971	170,243	44,452	104,321	19,809	57,404
Nebraska.....	1	8,960	44,800	8,959	44,793		
New Mexico.....	24	48,083	236,583	7,644	10,548	92,934	217,424
Oregon.....	126	113,445	820,089	41,420	504,645	135,561	266,046
South Dakota.....	10	2,662	12,787	420	640	2,807	9,641
Utah.....	23	17,710	105,920	17,837	97,667		
Washington.....	29	40,197	106,335			37,942	87,949
Wyoming.....	4	2,798	5,969	5,040	3,880	193	603
Total.....	535	780,452	3,312,983	236,146	1,289,088	587,587	1,664,515

Logging operations on private lands near or within the national forests are progressively extending the area of cut-over land. Much of it is beginning to revert to the counties or States, which are poorly prepared to assume the costs of its protection and regeneration. Many owners of heavily timbered lands have begun to doubt the feasibility of carrying their properties until the stumpage is in demand, and some are showing interest in the provisions of section 7 of the act of June 7, 1924, which authorizes the United States to accept donations of forest lands subject to the reservation of stumpage or other rights. Exchanges afford one means of bringing under Federal ownership and administration lands which would otherwise partly or wholly lose their productive value. Frequently adding such lands to the national forests markedly enhances the value of the latter through facilitating their protection and management, bringing slash hazards under control, and enlarging the control of erosion and floods. But in comparison with what needs to be done, the present exchange policy is of very inadequate scope.

The national forests contain almost 24,000,000 acres of State and private lands. Some 12,000,000 to 14,000,000 acres of these lands and several million acres of contiguous outside lands eventually should be under national-forest administration, since the private owners are not likely to assume the cost or responsibility of maintaining the forest or watershed values of these lands, the States presumably will not wish to do so, and the integral relationship of the lands to the national forests makes it possible to administer and protect them more effectively and economically as parts of these forests than in any other way. If those parts of the unreserved and unappropriated public domain unquestionably adapted to private management could be employed for land-exchange purposes under appropriate legislative authority, the fundamental purpose of existing land laws could be greatly furthered without any drain upon public funds.

LAND ACQUISITION THROUGH PURCHASE

Title was taken under the Weeks law, as amended by the Clarke-McNary law, to 417,064 acres, at a cost of \$1,512,181.22. Purchases totaling 507,922 acres and creating a total obligation of \$1,430,668.81 were approved by the National Forest Reservation Commission during the year. The average price of \$2.82 per acre for the lands approved for purchase and of \$3.63 for the lands actually acquired compares with a previous average of \$5.11 for all lands acquired. At the close of the year the average cost of all lands fully acquired, not including overhead, was \$4.93 per acre, the total \$16,818,602.02, and the area 3,413,293 acres distributed by States as shown in Table 7.

TABLE 7.—Acreage of timberland acquired in the fiscal year 1930, and total acquired to July 1, 1930, by States

State	Acquired in 1930	Average price per acre, 1930	Acquired up to July 1, 1930	State	Acquired in 1930	Average price per acre, 1930	Acquired up to July 1, 1930
	<i>Acres</i>	<i>Dollars</i>	<i>Acres</i>		<i>Acres</i>	<i>Dollars</i>	<i>Acres</i>
Alabama.....	7, 929	5. 20	104, 670	North Carolina.....	8, 062	4. 21	378, 555
Arkansas.....	99, 914	4. 15	246, 294	Pennsylvania.....	25, 997	4. 60	317, 333
Florida.....	85, 015	5. 00	85, 015	South Carolina.....	1, 113	6. 07	43, 490
Georgia.....	10, 047	5. 49	254, 999	Tennessee.....	3, 900	4. 30	376, 857
Louisiana.....	9, 613	3. 25	9, 613	Virginia.....	6, 996	4. 50	595, 949
Maine.....	121	5. 75	33, 482	West Virginia.....	35, 404	3. 96	278, 371
Michigan.....	71, 627	1. 65	144, 727	Wisconsin.....	15, 606	1. 28	15, 606
Minnesota.....	35, 440	1. 55	67, 579				
New Hampshire...	280	6. 89	460, 753	Total.....	417, 064	3. 63	3, 413, 293

Approval by the National Forest Reservation Commission, May 17, 1930, of four new purchase units initiated forest acquisition in three new States. The units are the Cumberland in Kentucky, the Homochitto in Mississippi, the Kiamichi in Oklahoma (and to a small extent in Arkansas), and the Evangeline in Louisiana.

The Cumberland unit is typical of the hardwood forests of Kentucky, and it embraces important parts of the watersheds of the Kentucky, Licking, and Cumberland Rivers, which, through the Ohio, belong to the Mississippi system. The Homochitto is representative of a very productive forest region and comprises parts of watersheds of the lower Mississippi. The Kiamichi is 90 per cent

shortleaf pine forest and includes portions of the watersheds of the Canadian and Porteau Rivers, which drain through the Arkansas, Kiamichi, and Little Rivers into the Red River. Timber production is the primary purpose of the Evangeline unit, which consists of excellent longleaf, loblolly, and hardwood soils, from which large quantities of timber have been removed. It drains into the Atchafalaya and Red Rivers.

Adjustments by the commission of boundaries of existing purchase units eliminated 14,546 acres of nonpurchaseable land from the Huron unit and 28,800 acres from the Marquette unit; added to the Keweenaw unit 91,520 acres and to the Superior 59,445 acres; and eliminated from the White Mountain unit an area of 130,912 acres within which no purchases had been made, offsetting the establishment of the Green Mountain unit in Vermont.

By the passage of the act of June 2, 1930, authorizing acquisition appropriations of not to exceed \$3,000,000 annually for the fiscal years 1932 and 1933, Congress established a new fiscal program and policy for carrying out the provisions of the Weeks law and the amendatory section of the Clarke-McNary law. While neither law prescribes any geographic restrictions upon land purchases, all considerations of public interest have joined to confine the field of purchases under these laws to the country east of the Great Plains. Here are found the major part both of our population and of our national timber consumption, the most numerous and important navigable streams, and the major part of our forest land, of which only an insignificant fraction is under permanent public management. It is within the eastern half of the United States that the forest problem is of largest proportions, most acute, and of most vital social and economic consequence. For these reasons the scope of the Federal program of forest-land purchases east of the one hundredth meridian is of deep public concern.

As population increases the rôle of water becomes increasingly important. It is indispensable to life, a source of power, a means of transportation, a contributor to recreation, beauty, the food supply. Inseparably related to water in our forest economy is timber, the basis of huge industries, the chief foundation of the economic life of wide regions, the dominant element in the existence of thousands of communities. The measures hitherto adopted to conserve these vital natural resources in the eastern United States are extremely inadequate.

Through the curtailment of the area used for farm-crop production, the area for which timber production is the highest economic use is increasing. An unofficial estimate compiled in 1929 with the cooperation of the State foresters places the amount of forest land east of the Great Plains at 375,707,000 acres, of which 6,319,494 acres, or 1.7 per cent, is in national forests, and 4,743,838 acres, or 1.3 per cent, in organized State forests. Other publicly owned lands, apparently inclusive of some unreserved public domain, total 4,638,902 acres, or 1.2 per cent. Thus only 4.2 per cent of the estimated total is in public ownership, and not all of that small fraction is receiving any care. An inquiry conducted by the Society of American Foresters in 1929 led to the conclusion that only 8,587,000 acres, or 2.4 per cent, of the remaining 360,000,000 acres in private ownership is under acceptable silvicultural management.

Such a situation challenges national attention. As seen by the several State foresters, the expansion of State forests affords the prospect of a total of 11,959,000 acres within the next 10 years, and of ultimately 36,665,925 acres. Unless private forestry develops far beyond any present promise, Federal forest expansion will be imperative. The National Forest Reservation Commission has approved a program of increased Federal acquisition in the East which contemplates the purchase of approximately 9,713,000 acres. This would bring the eastern national forests up to approximately 16,032,000 acres. The fruition of this program should be accelerated as rapidly as the national finances will allow. Each passing year adds to the difficulties of assembling units susceptible of the most efficient and economical administration and probably will add to the cost. Meanwhile there is need for establishment by Congress of a long-term fiscal policy and plan under which orderly and systematic progress can be made and definite programs formulated with assurance that the work can be carried out with the greatest economy and effectiveness.

SPECIAL USES

These embrace all uses of national-forest lands or resources other than timber, forage, and occupancy rights established under the general land laws or under permits issued by the Federal Power Commission. The adaptability of the national-forest lands to a wide variety of commercial, industrial, and recreational uses is recognized by the Forest Service in its management plans, and all proper forms of occupancy and use are authorized by permit. Uses of a public character or required to facilitate the use of other forest lands or resources are granted free; those of a commercial or exclusive character, at reasonable annual fees. A steady increase in this form of national-forest use is tied in with the growth and prosperity of many dependent localities whose commercial and industrial progress depends upon the fullest sound utilization of natural resources. Under present laws 5 acres is the largest area for which a permit can be issued for a definite term of years under conditions affording the security of tenure requisite to justify a substantial investment. The area limitation militates against development and should be modified to allow the issuance of term permits for areas up to 160 acres, in the discretion of the Secretary of Agriculture.

At the close of the calendar year 1929, 34,200 special-use permits were in effect, of which 15,959 were free and 18,241 involved an annual rental charge. The free permits increased by 191, the pay permits by 686. Receipts totaled \$300,257.30, an increase of \$13,138.22.

CLAIMS AND SETTLEMENT

Of reports on homestead claims, 132 were favorable and 23 unfavorable, the latter because of failure to meet the residential and cultivation requirements of the public land laws. Almost all of the homestead claims now requiring consideration have been initiated under the forest homestead law, and since all lands chiefly valuable for agricultural purposes have now been listed a progressive decrease in this class of cases is inevitable.

Of reports on mineral claims, 102 were favorable and 29 unfavorable. As in preceding years, fraudulent mining locations seeking title to lands chiefly valuable for other purposes imposed a heavy burden upon the Forest Service, partly through conflicts with the best use and development of the national forests and partly through the expenditure of time and money in their examination and the ensuing contests. The fact that title to public properties worth in some cases as much as \$2,500 per acre can be established under the mining laws if negligible indications of mineral exist, through superficial and perfunctory expenditures upon alleged development work, creates a situation which militates against the public interest. Abuses of the mining laws are not by miners but by speculators whose object is not to destroy large existing values by mineral development but to appropriate these values. There is urgent need for amendment of the mining laws to stop these gross abuses.

COORDINATION OF NATIONAL PARKS AND NATIONAL FORESTS

Four bills authorizing the President, upon joint recommendation of the Secretaries of Agriculture and the Interior, to transfer lands from national forests to national parks were enacted by Congress during the year. The act of May 7, 1930, related to the Yosemite Park; that of June 21, 1930, to the Rocky Mountain Park; that of June 12, 1930, to the Bryce Canyon Park; and that of July 3, 1930, to the Lassen Volcanic Park. Under authority of a previous act 7,726 acres were transferred from the Stanislaus National Forest to the Yosemite National Park by proclamation of April 14, 1930. At the close of the year steps were being taken to accomplish the transfers authorized.

Other proposed transfers of lands from national forests to national parks are receiving consideration. They involve the Kings River Canyon, now a part of the Sequoia National Forest in California; lands in the Sierra National Forest, Calif., to the east of the Yosemite Park; lands in the Rainier National Forest, Wash., to the east of the Rainier National Park; lands in the Teton National Forest, Wyo., to the east and south of the Yellowstone Park; and lands in the Santa Fe National Forest, N. Mex., tentatively suggested for establishment as the Cliff Cities National Park. None of these proposed transfers has been referred to or considered by the coordinating committee on national parks or forests, but certain changes in the east and south boundaries of the Yellowstone Park were studied in the field during July, 1929, by a special committee appointed by the President under authority of Congress.

ADJUDICATION OF NORTHERN PACIFIC LAND-GRANT CLAIMS

Preparations for the filing by the United States of the suit for the adjudication of the rights of the Northern Pacific Railway Co. under its land grants, as authorized by the act of Congress approved June 25, 1929, were approaching completion at the close of the year, and shortly thereafter suit was filed for hearing in the eastern judicial district in the State of Washington. Because of the important public interests and monetary values involved, this suit probably will rank as an outstanding case of its kind.

PROTECTION FROM FIRE

The number, size, and causes of fires on the national forests in the calendar year 1929, as compared with those of the previous year and the average of the past 5-year period, are shown in Table 8.

TABLE 8.—Comparison of fires on national forests, calendar years 1929, 1928, and 5-year average, 1925–1929

	Number of fires			Percentage of total		
	1929	1928	Average, 1925–1929	1929	1928	Average, 1925–1929
Class:						
Burns of 0.25 acre or less.....	4, 105	3, 873	3, 937	55. 11	55. 96	55. 58
Burns between 0.25 and 10 acres.....	2, 040	1, 914	1, 941	27. 39	27. 66	27. 40
Burns of 10 acres and over.....	1, 304	1, 134	1, 206	17. 50	16. 38	17. 02
Total.....	7, 449	6, 921	7, 084	100. 00	100. 00	100. 00
Cause:						
Railroads.....	290	281	306	3. 89	4. 06	4. 32
Lightning.....	3, 499	3, 195	3, 631	46. 97	46. 17	51. 26
Incendiarism.....	786	690	686	10. 55	9. 97	9. 68
Débris burning.....	305	230	234	4. 10	3. 32	3. 30
Lumbering.....	123	133	120	1. 65	1. 92	1. 69
Camp fires.....	702	717	670	9. 43	10. 36	9. 46
Smokers.....	1, 429	1, 345	1, 155	19. 18	19. 43	16. 31
Miscellaneous.....	315	330	282	4. 23	4. 77	3. 98
Total.....	7, 449	6, 921	7, 084	100. 00	100. 00	100. 00

Calendar year	Total area of national-forest land burned over	Total dam- age of na- tional-forest land burned over	Total cost of fighting fires, ex- clusive of time of forest of- ficers
1929.....	Acres 799, 082	Dollars 4, 338, 755	Dollars 3, 203, 191
1928.....	398, 900	833, 122	1, 193, 038
5-year average, 1925–1929.....	479, 225	2, 157, 308	1, 613, 620

Last year's report called attention to the declining percentage of the total area within the forests that has been burned over annually, as shown by the record of 5-year averages from 1910 to 1928. It was pointed out, however, that the rate of decline was tending to slow up, and that with the 1929 record added to complete the showing for the last five years this apparent slowness of recent progress might be emphasized. In reality the heavy losses that came later in the calendar year changed the apparent direction of the trend. The percentage of the gross area of the national forests burned over annually, by 5-year averages, 1910–1929, has been :

	Per cent
1910–1914, inclusive.....	0. 75
1915–1919, inclusive.....	. 60
1920–1924, inclusive.....	. 29
1925–1929, inclusive.....	. 33

This apparent reversal of the earlier progress in fire control is due to the phenomenon of the "bad year." The great bulk of the losses occurs in seasons of extreme weather conditions that enormously in- crease the difficulties both of fire prevention and of fire suppression. Each 5-year period from 1910 to 1924 included one such season,

whereas the 1925-1929 period included three. The result was to overbalance the gains made in preparedness and technical skill. The necessity of financing, organizing, and managing forest-fire activities on a basis of preparedness for the weather conditions encountered in the bad year is becoming more and more plain.

THE PROTECTION PROBLEM OF 1929

In severity the 1929 fire season can be compared only with the seasons of 1910 and 1919. On the whole, the conditions in 1929 are believed to have been more unfavorable than in either of the two previous record bad years. The three Pacific coast States, northern Idaho, and western Montana presented the outstanding protective problems.

The season opened promisingly and did not become abnormally severe until the latter part of the summer. In California, for example, the expenditures during the summer months were much lower than in 1928. But in 1928 the fire season was practically over by the middle of October, while in 1929 the worst of the season followed, with large fires in the last two weeks of the month and throughout November and with fires burning harder than they normally do in midsummer. On all forests in the Sierra Nevada country the fire season continued up to December 8, and on the forests in southern California up to the middle of January.

In the North Pacific States lightning storms caused serious fires in a period of extreme inflammability the latter part of July. By the middle of August 13 large fires out of control had burned over 35,000 acres of national-forest land in Washington and Oregon. Five or six years of severe drought had already passed in this region, and in 1929 only about half as much precipitation fell as the average for the five years preceding. June was the only month with any rain between May and October, and the quantity was not sufficient to have material influence. The prolonged drought had a cumulative effect on the forests, causing a decided loss of vigor, less lush plant growth, less moisture content in the tree foliage, utter dryness in the forest floor, and debilitation of the timber so that there was less resistance to and greater death from insect and fungus enemies. Consequently there had been a building up of inflammable material which enabled fires to spread more quickly and burn more intensely than they normally would.

In eastern Washington an electrical storm on August 2 started some 181 fires on three adjoining forests. Immediately after this storm there were several days of unusually low humidity and high wind. A single fire spread over some 7,000 or 8,000 acres in about three hours. With a number of large fires out of control, on August 11 came one of the worst fire days in the history of organized protection in the region. The humidity was extremely low, and the wind blew almost a gale. On the three forests, fires covered extensive areas. August 27 to 30 was another period of acute burning conditions, but except for one fire, which made a large additional spread, the fires in the region had been adequately controlled prior to that date and did not again escape.

Early in August, 1927, a similar electrical storm started an even greater number of fires on these three forests, but the losses and sup-

pression costs were relatively light. In 1929 the electrical storm was immediately followed by extremely bad fire weather; in 1927 control was facilitated by reasonably favorable weather. In 1929 the forest cover and humus were so parched that the smallest spark, carried by the wind a quarter of a mile or more from the edge of a controlled fire and falling in unburned material, would start a new fire which would at once spread rapidly. It was the unanimous opinion of the men handling the fires that never had they known them to burn so hard or spread so fast.

The large fires in eastern Washington were placed under control early in September, and more favorable weather followed. But the critical conditions transferred themselves to western Washington and Oregon. A heavy smoke blanket made detection and suppression extremely difficult. On September 12, 20 of the 22 forests in this district were closed to all forms of use except travel over regularly used roads and camping at established camp grounds. The Governor of Oregon postponed the opening of the hunting season. From September 10 to September 20 conditions reached their peak. A logging fire on the Mount Hood Forest burned over 40,000 acres and seriously threatened the town of Estacada. Another fire, starting outside the Columbia Forest, swept inside and in two days burned over 30,000 acres. Other large fires occurred elsewhere. Although on September 21 light showers, lower temperature, and high humidity relieved the situation somewhat, numerous fires started during the next three weeks, but few attained large size, and the fire season was apparently ended on October 9 by general rains. Late in November, however, large fires occurred in southern Oregon and continued throughout the month, while critical conditions lasted well into December. Normally the fire season closes in Washington and Oregon by September 10, except in southern Oregon, where September 30 is the recognized closing of the season.

Approximately one-half of the total fire-fighting expenditure during the fiscal year was in Montana and northern Idaho. In this region from August, 1928, to October, 1929, the precipitation was only 57 per cent of normal. Precipitation at the Weather Bureau station at Spokane, Wash., during 99 days following June 15, 1929, was but 0.11 inch. So great a deficit in rainfall necessarily brings acute fire conditions. An abnormally large number of fires had to be handled by a protection organization adequate only for a normal season. As in other dry years, large numbers of lightning fires started simultaneously. On the Clearwater Forest a storm on July 15 started 60 fires; on the St. Joe Forest 30 were started on July 14 and 27 on August 29; the Blackfeet had 35 fires started from a storm on August 8; the Kootenai had 27 fires started on August 2 and 41 on August 30. In early August extreme inflammability prevailed, and in the second and third weeks of the month the situation rapidly grew worse. August 23 was one of the worst fire days in the history of the region, rivaling the disastrous August 22 and 23 of 1910. Heavy gales caused the fires to run rapidly over great areas. A fire starting near Kalispell, Mont., on protective association lands outside the national forests covered on August 23 approximately 75,000 acres of national forest, national park, and private land, with extensive losses of improvements and property and irreparable

damage to choice portions of the Glacier National Park. At one time during the period from August 20 to August 31, 5,500 men were employed in fighting fires.

In this region normally general rain can be expected the first week in September. In the summer of 1929 none occurred until November 1. From September 1 to 10 the daily expenditure was \$40,000. During the rest of September scattered showers and longer nights relieved the situation to a marked degree, but fires occurred throughout October. Light general rains then definitely closed the fire season, at least 45 days later than usual.

The unprecedentedly prolonged season made necessary unusually large expenditures for mopping-up work. In previous years storms have aided in extinguishing fires or have put them out entirely. Last year no big fire was extinguished by rain.

The history of the Salmon River fire, on the Nezperce National Forest, illustrates the difficulties encountered. This lightning fire broke out on August 3, on the steep slope north of the Salmon River. To get to it the nearest man had to travel 8 miles without trail, with a 2,000-foot climb the last 3 miles. Starting immediately upon report of the fire, he reached it in a little less than three hours and found it had then covered approximately 25 acres. This man worked alone from 4 p. m. until 6 a. m. of August 4. In the meantime the fire spread considerably. At 4 a. m., August 4, a second man, dispatched on foot from the Salmon Mountain lookout nearly 20 miles away, after traveling partly over trails and partly through almost inaccessible country without trails, reached the scene. About 1 p. m. the ranger and his assistant arrived from the Deep Creek ranger station, more than 30 miles away, bringing food and some equipment. A trail crew of five men next reached the fire, between 4 and 5 p. m., having received word that morning by messenger and having traveled some 17 miles, partly by trails and partly through difficult country without trails. In spite of the efforts of the slowly assembling handful of men the fire, spreading rapidly on the steep, broken topography, finally reached large proportions. Before adequate reinforcements could be brought in it had spread to the Salmon River and along its north bank nearly 19 miles. It was finally brought under control by fire-fighting forces sent in from Missoula. The trip required three days and involved travel by road for 113 miles and walking over rough trails for from 36 to 46 miles. The fire covered about 20,000 acres, and its suppression cost approximately \$25,000.

In northern Minnesota a very serious fire situation developed early in July on the Superior National Forest, where the conditions generally were the worst in years. The Intermountain Region (Region 4) experienced the worst fire season since 1919, following bad general electrical storms on July 13. The season was considered the driest, hottest, and windiest of record in that region. Regions 2, 3, 7, and 8 had normal or below normal fire seasons.

The number of fatalities in the 1929 season was the greatest of any year except 1910.

The employees of the Forest Service whose lives were lost, so far as they are known, were Joe Aiken, Archie White, Lester Rudd, Tom Gorman, Norman K. Deem, Richard Gell, Douglas C. Ingram, Ernani St. Luise, J. F. Martin, William O. Makeiff, Fred E. Gibson,

Franz Frank, Robert Keys, Richard Cornett, Sam Swanson, and Paul Croxton. Men not on Forest Service pay roll at time of death were William A. Doelle, David Koontz, Philip Roe, C. S. Hutton, J. H. McCubbins, and Alvin Peoples.

SEASON OF 1930

The fire season of 1930 promises to stand in striking contrast with that of 1929. While the number of fires has been above the normal through the major part of the season, unusually few have been large. This is especially true in the Northern Region (Region 1), where 96 per cent of the 1,633 fires started up to September 10 were held below 10 acres in size. In the North Pacific Region (Region 6), likewise an unusually large percentage of fires have been held to small areas.

The spring season in all the western national-forest regions was generally favorable. In the North Pacific Region fire conditions became critical during July, and several particularly bad and large fires occurred on the Deschutes Forest, in Oregon, but better weather relieved the situation. There has been more rainfall in the western national forests than there was in 1929. The number of lightning fires has been about normal, but the electrical storms have been more scattered both in location and in time. In the Eastern National Forest Region the 1930 season has been unusually severe, with fires during June, July, and August on almost all of the forests. A great many fires were started by lightning on the Ouachita and Ozark Forests, in Arkansas—an unusual thing in the eastern forests.

PROGRESS IN PROVIDING THE MECHANISM OF PROTECTION

The quarter century since the Forest Service was created, February 1, 1905, by absorption of the old forest reserve organization into the Bureau of Forestry of the Department of Agriculture, has brought vast changes in the organization and methods that are employed in protecting the forests.

The field force in the first years was predominantly nontechnical; the forests were mainly unmapped wilderness solitudes; the methods and procedures were primitive. There was virtually no equipment, no experience, no precedent. Each supervisor and ranger had to meet emergencies as they arose, barehanded and unadvised. The changes that most strikingly set apart the protective organization and effort of the present day from that of the first five years are the result of a persistent struggle for better ways, better knowledge, and better accomplishment. Protection has continuously absorbed the major effort of the Forest Service and has accounted for the major part of the outlay upon the forests. It has progressed from a primitive, unorganized, catch-as-catch-can sort of struggle of untrained men against novel conditions into a highly developed technical branch of forest administration, with definite objectives and growing precision of attack at crucial points.

The forest-fire problem in the United States is unique. A combination of climatic conditions and human habits have created difficulties of forest-fire control such as no other country has had to meet. In their efforts to develop an adequate system of control American foresters have received practically no aid from the experience or literature of other countries. The difficulty of pioneering in this

field has been greatly increased by an unfavorable weather cycle and by rapidly increasing human use of the forests. In 1929 the length and severity of the usual period of summer drought in several regions surpassed all records since the creation of the national forests.

Yet in contrast with 1905, when destructive fires burned practically everywhere in the national forests without effective restraint, well over half the forests are now receiving a degree of protection that holds under one-tenth of 1 per cent the area annually burned over. Twenty-five years ago there was no detection system, with manned lookout stations on towers and mountain peaks, and connecting telephone lines. During the present season 1,473 watchmen with assigned stations on mountain peaks or towers served as the eyes of the fire-control organization. They used 451 towers and 950 structures erected for their shelter at their posts of duty. Of telephone line constructed and used for protection there was 37,148 miles.

In 1905 the number of rangers and guards employed was 466, 1 man to every 184,232 acres. In the summer of 1930, 3,676 men were employed as rangers and guards, or 1 to every 50,048 acres. In addition, from 5,000 to 8,000 men were employed on road, trail, or other work on the forests where they could be drawn upon for fire fighting or other fire duty, and nearly half of these men were given special fire training. If necessary, as many as 1,000 of these road and trail workers can be thrown into special positions in the protective organization as emergency lookout men, patrolmen, or firemen for any period of acute danger.

Formerly local residents took no regular part in the detection and suppression of forest fires, public sentiment usually ranging from indifference to a belief that forest fires were beneficial if no personal property was destroyed. At present the number of local residents with whom definite arrangements have been made to take part in detecting and suppressing fires probably exceeds 20,000. On or near many of the 733 ranger districts there is a considerable population, and in some instances several thousand persons are prepared to take part in fire fighting when needed. It is common for organized crews of cooperators to reach and suppress fires before forest officers arrive.

It is only in rather recent years that the necessity for personnel management as a means to successful fire control has been definitely recognized. No amount of money and equipment can accomplish fire control without good human engineering. The training of co-operators, improvement workers, fire guards, and all fire executives, while still in the development stage, is recognized as indispensable if men are to give a good account of themselves when the times of perplexity and stress come.

Important technical developments in forest-fire control concern such matters as determination of the complex of weather conditions constituting "fire weather," so that it is rapidly becoming possible for a forest officer to know when the degree of fire danger necessitates closing down logging operations to avoid unjustifiable risks of disaster. In the investigation of criminal violations of State and Federal fire laws forest officers have been trained to combine the technic of professional criminal investigations with the elusive skills of woodcraft, since neither type of skill will serve without the other. A method has been developed for determining the combination of

number and location of fire guards and road and trail location and mileage which will afford the most effective protection at a given annual cost. A method has also been developed for determining the length of time within which fires in a given area must be reached if losses are to be kept within a given limit.

Approximately 15,500 miles of road have been constructed primarily for fire control, and a large additional mileage which has been constructed for other purposes contributes to the speed with which fires can be reached. These roads are supplemented by 47,000 miles of trails which have been built by the Forest Service, almost wholly to meet the needs of fire-control activities.

Mechanical aids to fire control, formerly limited to such familiar tools as the ax and shovel, now include a long list of tools, implements, instruments, and machines, of which some have been invented to serve specific fire needs, and some have been taken over from industrial uses. Among them are instruments for measuring the moisture content of the litter on the forest floor; hand tools of numerous types; radio equipment designed to operate under the adverse conditions prevailing in rough timbered country; airplanes, which while not as helpful as is popularly supposed, have been used for over 10 years and might have a revolutionary effect on some phases of fire control if certain experimental efforts of inventors prove effective; various types of graders and other digging tools drawn by heavy tractors, which facilitate the construction of low-cost protection roads, permanent fire breaks, and temporary fire lines; and portable pumps, tank trucks, and other means of putting water on forest fires.

PROTECTION FROM INSECTS AND TREE DISEASES

Timber crops, like others, are always subject to injury from insects. Old stands of coniferous trees, such as cover large areas of the western national forests, are specially exposed to attack by bark beetles. These are ordinarily present only in sufficient numbers to attack successfully individual weakened trees. Occasionally, however, vast hordes develop and kill immense quantities of old-growth timber unless combated effectively. Like fires, these epidemics should be fought while they are still small.

Studies by the Bureau of Entomology have shown that the best way to prevent losses from these bark beetles is to kill the developing broods in trees which have been attacked. The trees containing these broods are sure to die, although the foliage may not turn brown until after the insects have reached the adult stage and emerged to attack other trees. There is no feasible method of saving a tree which has been attacked by thousands of pairs of adult bark beetles. The cutting or destruction of an infested tree in order to kill the brood of beetles in or under its bark does not, therefore, add to the loss of timber, but is comparable to the necessary cutting of trees in clearing a line around a forest fire. If the circumstances make possible the use of the wood, so much the better; but if not, the loss has already been incurred and the cutting or burning of the tree stops its use by the beetles as a breeding place and destroys the new generation.

During the year epidemic infestations were fought in old timber in Idaho, Wyoming, Montana, Oregon, and Colorado. The largest

single project was on the Coeur d'Alene National Forest, in Idaho, where very valuable western white-pine stands were threatened by a rapidly increasing bark-beetle infestation. A total of 22,841 trees were felled and the bark was peeled from the infested portion of the stem, thus exposing the grubs of the new generation of beetles to the dry air and to attack by small rodents and ants. This work was done in less than three months and necessitated the employment of 400 temporary laborers. Similar but smaller infestations in western white-pine stands on the Clearwater Forest, in Idaho, and the Kootenai Forest, in Montana, were also treated. The protection of the valuable timber on these areas was made possible by a deficiency appropriation.

Work was continued in the stands of lodgepole pine on the national forests west and south of the Yellowstone National Park. The trees there are smaller than in the white-pine region and their bark is not so thick. It is therefore practicable to spray oil on the infested trunks, and, by setting fire at the base, to heat the bark sufficiently to kill the grubs without the expense of felling and peeling the trees. About 70,000 infested lodgepole-pine trees were so treated on the Targhee, Teton, Wyoming, Caribou, and Cache National Forests. These infestations were a serious threat not only to the extensive stands of susceptible timber on the national forests but to those on the near-by Yellowstone National Park as well. On the areas where treatment had been impossible in previous years the beetles which emerged in the summer of 1929 were sufficient in number to attack and kill an average of two and one-half new trees for each previous host tree.

In Oregon another species of the same genus of bark beetles was fought on the Fremont and Deschutes National Forests, in cooperation with the owners of intermingled or adjacent timberland. This beetle attacks slow-growing trees of western yellow pine, a thick-barked tree. It was necessary to fell the trees and to peel off and burn the infested bark, at the same time exercising great care to prevent the escape of the fires.

On the Colorado National Forest, work on a troublesome infestation in western yellow pine was done, on a small scale, for the fourth successive year, and it is believed that the epidemic has been stopped. In this case felling and peeling the infested trees was sufficient to kill the grubs. Sales of mature timber for the manufacture of ties have helped to control this infestation.

On the Shoshone National Forest, in Wyoming, the local control of the spruce bud worm was undertaken, on an experiment basis, in cooperation with the Bureau of Entomology. This insect, in its larval stage, eats the needles of spruces, true firs, and Douglas fir, and can be fought only by spraying the trees with poison. The results of this effort will not be known until the growing season of 1931.

During the year the effects of the introduction, by the Bureau of Entomology, of a parasite of the pine-tip moth on the Nebraska National Forest became apparent. At one time the serious checking of the growth of the western yellow pine, in the sand-hill region, by the tip moth made the wisdom of planting that tree seem doubtful. This doubt has now been removed, after several years of cooperative

study and effort. The losses from the tip moth have been reduced to insignificance in the areas to which the introduced parasites have spread.

The white-pine blister rust continued its rapid spread in Idaho and Oregon. This disease is so deadly to all of the white (5-needled) pines that its control is a prerequisite to the growing of timber crops of those valuable trees. Fortunately, part of its life cycle is in the leaves of currants and gooseberries, and destruction of those plants in the vicinity of the pines makes control possible. During the year strips around Forest Service nurseries in Montana and West Virginia were cleaned of bushes of these alternate hosts, to prevent the possibility of the infection of nursery stock. This was accomplished through the cooperation of the Bureau of Plant Industry, but funds were not available for the much larger job of destroying the wild currants and gooseberries on about 1,500,000 acres of white-pine producing land in northern Idaho, western Montana, and northeastern Washington, where the largest values are now endangered. For the fiscal year 1931 a fund of \$25,000 was appropriated for beginning this protective task in cooperation with the Bureau of Plant Industry, but a much more rapid extension of the protected area will be necessary than can be effected with this annual amount if very serious losses are to be avoided in the western white-pine region. Furthermore, similar conditions are bound to develop in the sugar-pine region of California.

Surveys made during the year indicate that currants and gooseberries are not abundant on the eastern white-pine growing areas within the national forests in Virginia and North Carolina. The growing of this tree in this region will consequently not be hindered to the extent that had been feared. However, other species than white pine are being chiefly used in establishing plantations on the national forests in the Lake States and in Pennsylvania, partly because of the danger from this exotic rust.

TIMBER

More timber was cut on the national forests than in any previous year, and the receipts from sales were larger. The rate of increase, however, was less than in 1929, because of the depression in the lumber industry in the spring of 1930, especially on the Pacific coast. Including the timber cut in fulfillment of land-exchange agreements, there was cut in the fiscal year 1930 1,655,242,000 board feet, as against 1,502,001,000 board feet in the fiscal year 1929—an increase of about 10 per cent. Since the lumber production of the country was practically stationary in the calendar year 1929 and will apparently decrease sharply in 1930, the stability of the national-forest timber business is apparent.

During the 25 years since the Forest Service was organized the use of national-forest timber has grown vastly. Last year six national forests each cut more timber than was taken from all the national forests in 1905. The growth has not been even by fiscal years, some showing large gains and others small losses when compared to those just preceding. The general movement is illustrated by the following figures:

Timber cut on all national forests under sales and exchanges

Year	Board feet	Year	Board feet
1905-----	68, 000, 000	1920-----	806, 000, 000
1910-----	380, 000, 000	1925-----	1, 038, 000, 000
1915-----	566, 000, 000	1930-----	1, 655, 000, 000

As has been frequently emphasized in previous reports, this growth has not been brought about by crowding national-forest timber on the market and seeking the establishment of new large sawmills. It has been due in recent years primarily to purchases by established lumber companies which had exhausted their privately owned timber or were logging intermingled or adjacent holdings. Especially since 1920, the increased cut has gone chiefly to mills which needed it if they were to continue as industrial enterprises, giving employment to labor and forming the economic basis for the communities which have grown up around them. The largest sale made during the year, one of 852,000,000 board feet on the Olympic National Forest in Washington, is an illustration. This timber was awarded, under competitive bids, to a company which has cut nearly all the privately owned timber available to it and in default of obtaining public timber was faced with the alternative of ceasing operation and dismantling its plants, to the detriment of the community.

The establishment and development of national forests east of the Great Plains has aided in the stability and growth of the timber use. The cut of the year on these forests was 112,000,000 board feet and brought \$572,000. Much of this timber was made into other products than lumber.

A commensurate increase with that of the timber business has taken place in knowledge of methods for keeping the land growing timber. In 1905 no trained foresters had had experience in handling western tree species and very little was known of the practical silvicultural and fire-precautionary measures best for each of the western forest types. Many of the early sales were trials of theory in these matters. The results of research and of practical experience accumulated during 25 years under the leadership of competent foresters now furnish a basis for confident action. The study of cut-over areas after 10 to 25 years is the real test of the value of or errors in the methods of cutting and the protective measures applied when the sale was made. The national-forest timber resource has been made available for use under a system of regulation designed to provide that the output shall be continuous, that new crops shall replace those cut, and that stability and permanence shall be given dependent industries and communities. The technical information and skill is now available to handle the increasing volume of cutting so as to carry out fully the wise provisions of the basic law for national-forest administration.

At the close of the year over 2,000,000 cords of pulp wood on two areas near each other in the mountains of Colorado were being advertised for sale and subsequently were awarded to the highest bidder among three reputable paper-manufacturing companies. This will constitute the first large-scale utilization of the spruces and true firs of the Rocky Mountain region. These species have not been in demand as saw timber or tie material, and their use for paper making

has been prevented by the lack of paper mills in the region. The progressive depletion of the Lake States spruce explains the newly awakened interest of paper companies in the Colorado timber. The sale is, therefore, indicative of the continued trend of wood manufactures to the West as the eastern supplies of old timber approach exhaustion. It also indicates the increasing use of national-forest timber for pulp products, which is confidently expected to expand materially in future years.

Heretofore, large sales of pulp wood to form the chief source of supply for large paper mills have been awarded only in Alaska, and active operations there have necessarily been delayed for the engineering examinations now nearing completion which must precede the heavy investments in the development of water power and the construction of mills. Pulp wood has been cut on national forests in Maine, New Hampshire, North Carolina, Michigan, Minnesota, Idaho, and Washington, and shipped to established paper mills to supplement other supplies, and in Virginia chestnut wood from the forests has been used for paper making after the tannic acid had been extracted. The Alaska sales, the Colorado sales, and one of 510,100,000 board feet made during the year on the Snoqualmie National Forest, in Washington, are each expected to constitute the chief timber backing for paper mills. The timber will be cut no faster than growth will replace it within the tributary unit of which the sale area forms a part, thus providing for a permanent enterprise in each case.

The national-forest timber sale business of the calendar year 1929 is summarized in the Tables 9, 10, and 11.

TABLE 9.—*Quantity and value of national-forest timber cut under sales, calendar year 1929*

State	Quantity cut			Value		
	Commercial sales	Cost sales	Total	Commercial sales	Cost sales	Total
	<i>Board feet</i>	<i>Board feet</i>	<i>Board feet</i>	<i>Dollars</i>	<i>Dollars</i>	<i>Dollars</i>
Alabama.....	3,000		3,000	20		20
Alaska.....	47,462,000		47,462,000	71,409		71,409
Arizona.....	112,786,000	238,000	113,024,000	281,592	239	281,831
Arkansas.....	21,000,000	132,000	21,132,000	140,415	133	140,548
California.....	401,083,000	1,732,000	402,815,000	1,172,110	1,116	1,173,226
Colorado.....	54,189,000	798,000	54,987,000	150,803	776	151,579
Florida.....	6,104,000		6,104,000	19,716		19,716
Idaho.....	115,528,000	5,278,000	120,806,000	431,783	4,760	436,543
Michigan.....	5,198,000		5,198,000	9,964		9,964
Minnesota.....	5,789,000		5,789,000	22,920		22,920
Montana.....	36,506,000	3,774,000	40,280,000	105,524	4,016	109,540
Nevada.....	847,000	233,000	1,080,000	1,224	200	1,424
New Hampshire.....	14,267,000		14,267,000	91,943		91,943
New Mexico.....	15,438,000	618,000	16,056,000	36,558	644	37,202
North Carolina.....	14,412,000		14,412,000	49,797		49,797
Oregon.....	225,907,000	3,111,000	229,018,000	677,912	2,130	680,042
Pennsylvania.....	2,645,000		2,645,000	5,632		5,632
South Dakota.....	48,659,000	555,000	49,214,000	176,068	593	176,661
Tennessee.....	5,778,000	92,000	5,870,000	10,307	99	10,406
Utah.....	10,224,000	832,000	11,056,000	21,865	883	22,748
Virginia.....	15,038,000	9,000	15,047,000	41,908	10	41,918
Washington.....	184,053,000	232,000	184,285,000	398,725	147	398,872
West Virginia.....	1,663,000		1,663,000	5,211		5,211
Wyoming.....	57,696,000	1,279,000	58,975,000	162,680	1,187	163,867
Total, 1929.....	1,402,275,000	18,913,000	1,421,188,000	4,086,086	16,933	4,103,019
Total, 1928.....	1,319,738,000	16,876,000	1,336,614,000	3,751,297	15,142	3,766,439

¹ In addition, minor products not convertible into board feet were cut, value \$18,134.

² In addition, minor products not convertible into board feet were cut, value \$23,503.

TABLE 10.—Quantity and value of national-forest timber sold, calendar year 1929

State	Quantity sold			Value		
	Commercial sales	Cost sales	Total	Commercial sales	Cost sales	Total
	<i>Board feet</i>	<i>Board feet</i>	<i>Board feet</i>	<i>Dollars</i>	<i>Dollars</i>	<i>Dollars</i>
Alabama.....	20,000		20,000	95		95
Alaska.....	39,560,000		39,560,000	56,400		56,400
Arizona.....	47,227,000	260,000	47,487,000	104,414	249	104,663
Arkansas.....	74,036,000	222,000	74,258,000	636,333	222	636,555
California.....	118,044,000	1,780,000	119,824,000	296,894	1,224	298,118
Colorado.....	28,078,000	852,000	28,930,000	69,411	891	70,302
Florida.....	43,810,000		43,810,000	236,379		236,379
Idaho.....	58,316,000	4,254,000	62,570,000	157,383	4,026	161,409
Michigan.....	3,077,000		3,077,000	4,661		4,661
Minnesota.....	22,953,000		22,953,000	73,324		73,324
Montana.....	58,829,000	4,438,000	63,267,000	188,691	4,675	193,366
Nevada.....	1,007,000	278,000	1,285,000	1,487	229	1,716
New Hampshire.....	12,218,000		12,218,000	50,027		50,027
New Mexico.....	32,017,000	834,000	32,851,000	89,225	825	90,050
North Carolina.....	14,288,000		14,288,000	43,313		43,313
Oregon.....	186,385,000	2,880,000	189,265,000	590,869	1,988	592,857
Pennsylvania.....	7,764,000		7,764,000	24,124		24,124
South Dakota.....	33,788,000	271,000	34,059,000	128,902	299	129,201
Tennessee.....	4,800,000	114,000	4,914,000	10,986	120	11,106
Utah.....	23,010,000	1,092,000	24,102,000	59,842	1,177	61,019
Virginia.....	18,611,000	3,000	18,614,000	28,990	3	28,993
Washington.....	171,525,000	171,000	171,696,000	360,104	108	360,212
West Virginia.....	530,000		530,000	1,574		1,574
Wyoming.....	32,175,000	1,377,000	33,552,000	85,099	1,247	86,346
Total, 1929.....	1,032,068,000	18,826,000	1,050,894,000	3,298,527	17,283	¹ 3,315,810
Total, 1928.....	2,669,996,000	19,920,000	2,689,916,000	7,765,647	18,020	² 7,783,667

¹ In addition, minor products not convertible into board feet were sold, value \$50,010.

² In addition, minor products not convertible into board feet were sold, value \$22,629.

TABLE 11.—Number of national-forest timber sales, classified according to amounts of sale, by States, calendar year 1929

State	\$500 or under commercial sales	\$500 or under cost sales	Total	\$501 to \$1,000	\$1,001 to \$5,000	Over \$5,000	Grand total
Alabama.....	3		3				3
Alaska.....	210		210	14	10	1	235
Arizona.....	1,068	185	1,253		1	2	1,256
Arkansas.....	54	79	133			8	141
California.....	578	321	899	5	13	20	937
Colorado.....	651	208	859	4	13	2	878
Florida.....	121		121	1	1	3	126
Idaho.....	902	1,315	2,217	15	14	8	2,254
Michigan.....	57		57	1			58
Minnesota.....	203		203	2	7	5	217
Montana.....	666	932	1,598	4	10	6	1,618
Nevada.....	70	102	172				172
New Hampshire.....	170		170	3	2	4	179
New Mexico.....	1,041	508	1,549	3	5	4	1,561
North Carolina.....	322		322	2	7	3	334
Oregon.....	593	562	1,155	7	6	13	1,181
Pennsylvania.....	9		9	3	2	1	15
South Dakota.....	284	58	342	1	12	11	366
Tennessee.....	217	40	257	1	2		260
Utah.....	256	613	869			1	870
Virginia.....	377	2	379	1	2	1	383
Washington.....	207	35	242	7	11	12	272
West Virginia.....	22		22				22
Wyoming.....	249	270	519	1	4	2	526
Total, 1929.....	8,350	5,230	13,560	75	122	107	13,864
Total, 1928.....	7,934	5,630	13,564	42	113	72	13,791

PLANTING

The national forests contain over 2,000,000 acres of open, unproductive land that can be restored to productivity within a reasonable time only by tree planting.

Planting has not kept pace with other national-forest activities. The first 10 years of administration, from 1905 to about 1915, were a period of experimentation to develop practical low-cost methods. During the next 10 years the World War and the restrictions upon governmental expenditures that followed prevented any material expansion of the work. In 1916, 10,396 acres were planted or sown, and in 1925, 11,565 acres. During the last five years there has been a gradual expansion as small increases in appropriations became available. About 18,000 acres are now being planted annually, with nursery developments under way which when completed will permit an increase to about 25,000 acres, if the appropriation continues unchanged. The national forests now contain about 150,000 acres of successful plantations, after eliminating failures due to droughts, fires, and other causes.

The expansion of the national-forest area in the Lake States and elsewhere is adding new lands in need of planting faster than the rate at which the work is now going forward. In the West, despite steady progress in reforesting old burns, disastrous fires have increased the denuded acreage, especially in northern Idaho, western Montana, and parts of Washington. Thus, the total area needing planting tends to increase rather than diminish. The program for the establishment of additional nursery capacity and enlarged planting operations calls for development on the eastern forests first, because of their accessibility to the centers of population and their potential productivity, with subsequent enlargement of the planting activity on the burned areas in the Rocky Mountain and Pacific Coast States. This program is already under way. In 1925, 37 per cent of the acreage planted was east of the Great Plains, in 1929 about 60 per cent.

The act of June 9, 1930, commonly referred to as the Knutson-Vandenberg Act, set up a fiscal program for national-forest planting by authorizing appropriations for subsequent fiscal years. If appropriations are made in the amounts authorized, planting can be brought into balance with other activities on the eastern national forests, but no material enlargement in the West is possible.

The same act authorized the requirement of a special deposit by timber-sale purchasers to be used for planting the area cut over, if necessary because of any failure of desirable natural reproduction. This authority will be of great aid in some exceptional cases where the clear-cutting of the old timber crop and the planting of a new one is the best practice, economically or silviculturally. Any excess of such a deposit over the cost of doing the work will be handled as a receipt from the sale of the timber.

The first planting on national-forest land in Wisconsin was done in the spring of 1930, when about 400 acres of recently acquired open land on the Moquah purchase unit were reforested with trees from the nursery at Cass Lake, Minn. A new nursery in Wisconsin is one of the urgent needs.

It will be 1933 before the nursery enlargements now in progress are fully reflected in acreage planted. The areas planted and sown in the calendar year 1929 are shown in Table 12.

TABLE 12.—Planting and sowing on national forests, by States, calendar year 1929

State	Area planted	Area sown	Total	State	Area planted	Area sown	Total
	<i>Acres</i>	<i>Acres</i>	<i>Acres</i>		<i>Acres</i>	<i>Acres</i>	<i>Acres</i>
Michigan.....	8, 779. 70	-----	8, 779. 70	West Virginia.....	77. 60	0. 50	78. 10
Idaho.....	2, 226. 94	-----	2, 226. 94	Virginia.....	48. 07	-----	48. 07
Minnesota.....	1, 468. 00	-----	1, 468. 00	California.....	33. 73	2. 00	35. 73
Washington.....	1, 303. 00	-----	1, 303. 00	Utah.....	21. 25	-----	21. 25
Nebraska.....	1, 215. 17	-----	1, 215. 17	North Carolina.....	15. 00	-----	15. 00
Colorado.....	1, 164. 99	-----	1, 164. 99	Tennessee.....	12. 25	2. 00	14. 25
Oregon.....	782. 50	-----	782. 50	Oklahoma.....	13. 60	-----	13. 60
Montana.....	321. 64	-----	321. 64	Nevada.....	. 20	-----	. 20
Florida.....	308. 22	5. 00	313. 22				
Pennsylvania.....	298. 30	1. 50	299. 80	Total.....	18, 196. 59	11. 00	18, 207. 59
Wyoming.....	106. 43	-----	106. 43				

RANGE

GENERAL RANGE AND LIVESTOCK CONDITIONS

Except in the Southwest, the winter of 1928-29 was severe. A highly erratic spring and summer followed. Most of Colorado and portions of Wyoming had a dry, cold, late spring, more than usual summer rain, and a forage crop above normal but of less than average quality. In other portions of Wyoming, all of Montana, and pretty generally throughout the intermountain and Pacific coast regions a fairly good spring was succeeded by the highest temperatures and lowest rainfall for the longest period known for many years. Ranges were generally too closely grazed, some livestock had to be removed before the end of the grazing season, and weights of animals were slightly under normal.

In the Southwest the situation was somewhat improved over previous years. Despite a preceding season of deficient rainfall, livestock entered the winter of 1928-29 in fair to good condition but with an inadequate supply of winter feed. A generally mild winter and light snowfall, together with the good condition of national-forest ranges brought about by conservative stocking, limited heavy losses to local areas. The soundness of a policy which reserves a food supply to meet emergency conditions was amply proved. On most of the national-forest ranges in Arizona and New Mexico the spring brought considerable moisture and favorable growing conditions, but some areas were extremely dry until the summer rains, which were as a rule abundant and timely, but in some localities inadequate. An extremely dry fall followed, with a serious shortage of stock water in places; but abundant precipitation in December and January greatly improved the situation everywhere. With some exceptions, the forage was above average in growth, but the weights of animals and the calf and lamb crops were only fair to good.

Generally throughout the West the subnormal precipitation of the past few years has diminished the underground water supplies. The resulting shortage of water for irrigation and domestic purposes has led to some demands for the removal of livestock from forests upon the erroneous assumption that grazing is denuding the watersheds. Keen public appreciation of the value of ground cover, whether it

be brush, timber, or grass, in preserving watersheds is most desirable. Experience with these dry periods emphasizes the necessity of stocking ranges conservatively rather than on the basis of the good year. Surplus feed is an insurance against range depletion and loss of live-stock values during emergency periods, as well as an evidence that watershed values are being conserved.

Favorable cattle markets throughout 1929 gave growers a stronger financial position than for some years. This in turn was reflected in better care and management of herds on the national forests and better satisfied permittees. In contrast, the condition of the sheep industry was rather discouraging. Wool dropped to the lowest level since 1921, and lamb prices declined. The year marked the end of a cycle of prosperity in the business, and much pessimism prevails as to the future.

Times of depression bring out the value of the national-forest range, with its assured stability and encouragement for the grower through efficient management to offset low prices by lowered death losses and increased weights of lambs. Efficient labor and good supervision during the summer season are essential alike to the success of the business and to good range management. The need of the latter has been made more obvious and more urgent by the long periods of deficient precipitation, which have left their mark on all western ranges. The permanence of the effect probably can not be fully determined until better seasonal conditions arrive. It is certain that for the present the volume of production of forage has been decreased and range capacity impaired. For this reason careful attention has been given to reducing use promptly when the signs of range decline appear.

TABLE 13.—Grazing permits issued and number of stock grazed on the national forests, by States, calendar year 1929

State	Cattle, horses, and swine				Sheep and goats		
	Permits issued	Stock grazed			Permits issued	Stock grazed	
		Cattle	Horses	Swine		Sheep	Goats
Alabama.....	1	8	2				
Alaska.....	3	28					
Arizona.....	1,042	182,659	1,997	391	125	323,736	1,397
Arkansas.....	19	205					
California.....	1,824	146,371	5,606	265	362	431,789	1,909
Colorado.....	2,878	274,873	4,111		925	1,077,223	701
Florida.....	5	164			3	1,005	8
Idaho.....	2,756	118,773	8,118		1,028	1,378,240	
Montana.....	1,929	121,216	9,255		495	612,828	65
Nebraska.....	32	10,808	498				
Nevada.....	328	48,318	2,021		153	313,534	
New Hampshire.....	17	139	38				
New Mexico.....	1,958	80,716	3,341	134	294	243,904	10,427
North Carolina.....	50	286	1	14	13	124	
Oklahoma.....	51	2,528	80				
Oregon.....	1,072	83,848	3,134		504	657,172	80
South Dakota.....	521	25,271	1,059		35	30,283	
Tennessee.....	31	230	3		5	149	
Utah.....	4,139	109,114	4,146	49	2,152	778,884	900
Virginia.....	62	666	1		17	467	
Washington.....	393	12,495	538		142	169,535	
West Virginia.....	8	82	2		23	599	
Wyoming.....	754	103,667	4,220		298	631,247	
Total, 1929.....	19,873	1,322,465	48,171	853	6,574	6,650,719	15,487
Total, 1928.....	19,967	1,335,903	51,956	1,206	6,457	6,509,421	17,070

With 13,438 fewer cattle but 141,298 more sheep permitted in 1929 than in 1928, and with 5 sheep reckoned as the equivalent of 1 cow in forage requirements, the national-forest ranges carried during 1929 a net livestock increase over 1928 equivalent to 14,822 more cattle. Compared with 1925 the number was 118,786 less—about 4.3 per cent. In the same period the number of livestock in the 11 Western States declined about 15.5 per cent. Fluctuations in numbers and class of stock must be expected in response to varying economic and physical conditions. The recent swing toward sheep will probably now be reversed.

STABILITY OF RANGE USE

National-forest range administration has kept up with economic requirements. When the forests were first placed under the Department of Agriculture in 1905, most of the ranges were seriously overgrazed. Some were in about the same condition that now characterizes a large part of the public domain. One of the first tasks imposed on the Forest Service was to reduce heavily the numbers of stock admitted. Exclusion began with the transient and nomadic stock. On the Sierra Forest in California, for example, some 400,000 head of sheep were excluded at the outset. Other forests were similarly overgrazed by nomadic bands of sheep, while resident owners were in many cases grazing far more cattle, horses, and sheep than the range would safely carry.

In order to permit adjustment in the business, a policy of gradual reduction was adopted. It was not until about 1910 that the conditions on the various ranges were known well enough to determine how great reductions would be requisite. Many areas were then, and even later, still seriously overgrazed. There were no criteria for regulating the use of grazing lands until the Forest Service developed them. The working out of plans and policies, the settlement of conflicts, the determination of seasons of use, the prevention of premature grazing, the definite assignment of allotments to individuals, and the reduction in numbers of stock all required time to work out.

The acreage of the grazing lands has been another important factor. Over 30,000,000 acres have, for one reason or another, been withdrawn from grazing use during the past 20 years. About 20,000,000 acres, including some of the very best grazing lands, were eliminated from the forests. Over 4,000,000 acres have been closed to the grazing of livestock in the interest of game, timber, watershed, and recreational protection. The equivalent of approximately 2,000,000 acres has been withdrawn from grazing use through reductions in the permitted number of domestic stock on the 278 Federal and State game refuges. Some 2,250,000 acres were listed, filed on, and patented under the forest homestead act of June 11, 1906. This land also included some of the very best grazing land, and its settlement often cut out the heart of the range. The encroachment of timber reproduction due to protection of the forests from fire has gradually reduced the carrying capacity of the 42,000,000 acres of timberland used for grazing purposes by an estimated 10 per cent, the equivalent of an area decrease of over 4,000,000 acres. All told, these changes have virtually reduced the usable grazing lands by 20 to 30 per cent.

The actual decline in the number of stock grazed, with sheep reduced to cattle on a ratio of 5 to 1, is less than 15 per cent.

The land in the national forests is constantly changing. Additions are being made through land exchange and purchase, while some grazing lands have been passing from public ownership. Within recent years, however, the additions have usually been timber-producing lands of low value for grazing. Notwithstanding these changes during the past 20 years, the ranges have maintained a stable livestock industry. Overgrazing conditions have largely been overcome and the depleted forage resource has been built up to a state of sustained productivity without seriously interfering with the business of the range users.

Economic conditions, of course, play an important part in the numbers of livestock grazed year by year. From 1910 to 1918 the number of cattle in the 11 Western States increased 39 per cent, while the number on the national forests increased 55 per cent. In 1919 the number in the 11 Western States declined 5 per cent, but the number on the forests maintained the 1918 level. From 1918 to 1929 the number on the national forests declined to 4.5 per cent below the 1910 level, and the number in the 11 Western States declined in about the same proportion. Approximately the same comparison can be made with sheep.

The large increase in number of stock both in the Western States and on the national-forest ranges from 1916 to 1918 was due to war requirements, and the subsequent decline was largely postwar deflation. The ranges were heavily overstocked to meet the war emergency, and the economic adjustments which followed brought about a reduction which would have had to be made anyway. In some instances it is still in process. During it stockmen have taken advantage of the provision in the regulations authorizing a continuance of their established preferences upon application, without continuous use. All such preferences impose an obligation on forest range which must be met when the permittee restocks. In 1929 preferences were carried over on 100,000 cattle and 436,159 sheep by the application of the nonuse provision of the regulations. These numbers are not included in any of the above tables. Neither do the tables include over 100,000 cattle and horses grazed on the national forests free of charge by settlers, miners, tourists, and the like.

The number of stock grazed on the forests is about 3 per cent less than the number for which permits are issued. This difference is due to the inability of the permittees to determine at the time they make application the exact number of stock they may have after spring losses and when the grazing season opens.

Numbers alone are not a true criterion of what the forests have really supported during the last 20 years. Improved practices of range livestock management which have been introduced since 1910 have increased the forage requirements for a given number of animals covered by permit. In 1910 the number of lambs averaged about 75 per cent of the number of ewes; in 1929, about 95 per cent. Animals under 6 months of age are not counted or charged for. Further, as a result of early lambing and the improvement of breeds

in the mutton type, lambs are larger and older now when they go on the forests than they were in 1910 and therefore consume a greater amount of forage. Improvement in breeds has materially increased the weights of both cattle and sheep. Without adequate feed, however, improvement in breeds would not accomplish full results in increasing weights. For all classes of marketable animals weights have increased greatly during the past 20 years.

In recognizing established preferences it has been a fundamental principle throughout that no rights are acquired, but that the grazing privilege is subject to revocation at any time the land is being injured or is needed for other purposes. The regulations further provide for the admission of new applicants by a reduction in numbers of stock of the larger owners. The number of cattle and horse owners during the past five years has averaged 21,362 and of sheep and goat owners 6,207. The average number of cattle per permittee in 1929 was 70 and of sheep 1,023.

In 1912 the average number of cattle per permittee was 71, or 1 more than in 1929, and of sheep 1,421, or 398 more than in 1929. This decline was due partly to the depression in the sheep business from 1919 to 1922, but also partly to the fact that over 1,200 more permittees grazed sheep on the national forests in 1929 than in 1912. Changes from cattle to sheep have also been an influencing factor. The larger owners in both classes of stock are practically the same as were using the forests in 1912, with a slightly decreased average number of stock per permit.

For all permits covering over 200 cattle the number per permit averaged in 1912, 524 as against 445 in 1929. For sheep permits covering over 2,500 head the average in 1912 was 4,812, and for 1929, 4,575; but in 1912, 93 per cent of the cattle permittees grazed under 200 head each, and 87 per cent of the sheep permittees grazed under 2,500 head each. In 1929 the corresponding percentages were: For cattle, unchanged; for sheep, 91. In 1912 the cattle permittees for over 200 head grazed 50 per cent of all the cattle permitted, and in 1929 47 per cent, while the sheep permittees for over 2,500 head grazed 44 per cent of all the permitted sheep in 1912, as against 38 per cent in 1929.

These figures make clear that while the trend has been toward a wider distribution of the grazing privilege and a decreasing proportion of range use by large owners, the change over a considerable period of years has been such as to indicate a high degree of conservatism in the procedure and stability for the industry, not violent or drastic disturbances. In the report for last year the stability of range use was brought out from another angle, through a comparison between the number of stock and permittees and the acreage of usable range in 1909 and 1928. The estimate of the area of usable range in 1909 shown in that comparison failed to make allowance for all the factors that require to be given weight in working out the comparative showing. These factors have already been explained above. A corrected comparison, with 1929 substituted for 1928, is shown in Table 14.

TABLE 14.—*Number of permits and number of stock grazed in the western national forests in 1909 and 1929*

Year	Cattle, horses, and swine			Sheep and goats			Area in national forests	
	Permits	Stock	Average per permit	Permits	Stock	Average per permit	Total	Usable range
1909.....	<i>Number</i> 22, 163	<i>Number</i> 1, 585, 905	<i>Number</i> 72	<i>Number</i> 5, 074	<i>Number</i> 7, 819, 594	<i>Number</i> 1, 541	<i>Acres</i> 161, 534, 792	<i>Acres</i> 115, 000, 000
1929.....	19, 677	1, 369, 620	70	6, 513	6, 663, 854	1, 023	132, 922, 823	83, 820, 642

Using the accepted ratio of 5 sheep as the grazing equivalent of 1 cow, the average area per head of stock was 37 in 1909, as against 31 in 1929. That the average carrying capacity per acre is substantially greater than it was in 1909 is obvious. By conserving and building up the range resource as well as by its policies relating to range use, national-forest administration has been the principal means of securing to the dependent range livestock industry a highly stable in place of a highly unstable condition.

TERM PERMITS

As shown in Table 15, term permits were issued during 1929 for 50.7 per cent of the cattle and 61.3 per cent of the sheep, an increase over 1928 of 3.2 per cent for cattle and 0.3 per cent for sheep.

TABLE 15.—*Term or 10-year permits for grazing stock on the western national forests, 1929*

Region	Number of term permits issued		Per cent of total		Number of stock under term permits		Per cent of total		Total number of permits issued		Total number of stock permitted	
	Cattle and horses	Sheep and goats	Cattle and horses	Sheep and goats	Cattle and horses	Sheep and goats	Cattle and horses	Sheep and goats	Cattle and horses	Sheep and goats	Cattle and horses	Sheep and goats
1.....	557	139	27. 2	24. 0	57, 935	250, 123	41. 6	32. 9	2, 050	579	139, 338	760, 128
2.....	1, 033	357	25. 6	30. 6	154, 929	684, 362	39. 9	44. 0	4, 036	1, 168	388, 761	1, 554, 661
3.....	922	165	31. 2	39. 6	140, 062	399, 626	50. 9	60. 9	2, 951	417	275, 175	656, 049
4.....	6, 681	2, 949	90. 9	88. 3	287, 483	2, 449, 431	84. 4	90. 7	7, 351	3, 341	340, 443	2, 701, 382
5.....	338	83	18. 5	22. 9	47, 683	133, 975	31. 4	30. 8	1, 824	362	151, 687	435, 386
6.....	190	248	13. 0	38. 4	20, 254	349, 219	20. 0	40. 9	1, 465	646	101, 152	852, 798
Total..	9, 721	3, 941	49. 4	60. 5	708, 346	4, 266, 736	50. 7	61. 3	19, 677	6, 513	1, 396, 556	6, 960, 404

NONUSE OF RANGE

As has been mentioned in previous reports, nonuse of range has been granted to permittees with established preference when the permittee is prevented from exercising his privilege by business requirements. In 1929 grazing privileges were thus retained for nearly 100,000 cattle and over 430,000 sheep. For cattle this was the same number as in 1928, but for sheep an increase of over 82,000 head. With a further decline in the sheep industry threatened, an increased demand for nonuse and for changes from sheep to cattle is probable. The Forest Service is prepared to meet that situation as it has been met in the past.

Nonuse will be granted all deserving applicants who are unable to place all or a part of their preference number of stock on the range because of foreclosure of mortgage or other circumstances beyond their control. If the range thus vacated needs a rest, it will be closed to use. In cases of this kind the length of the nonuse period will be determined by the needs of the range. If the range is in good condition, it may be used temporarily by other approved applicants as a measure of relief to other ranges or to accommodate new applicants on a temporary basis.

Action on applications for change in class of livestock will likewise be governed by the present policy, stated in my report for 1929. Execution of these general policies rests upon local forest officers with full authority. This local control and flexibility of regulation meets the fluctuating demands of the livestock industry in a way that is not often paralleled in comparable private business transactions.

RANGE MANAGEMENT

The development of range-management plans during 1929 made satisfactory progress. Range users are taking a more active interest in them and are generally accepting them as indispensable in securing the greatest returns. Time emphasizes the relation of labor to the successful application of the plans. As a rule the man in charge of stock is perforce given wide latitude to exercise his judgment without close supervision. Nevertheless, the extent to which the owner shows interest, gives general directions, keeps his camps properly supplied with food, salt, etc., pays adequate wages, and classifies his herds so as to permit the kind of management range conditions dictate will by and large determine his profits. This is especially true in periods of depression, when a few pounds of increased weight in lambs or beef at least partly make up for lower market prices.

Supervision and management of the herds while on the range is a distinct responsibility of the owner, which the Forest Service does not attempt to assume, although it can and does prescribe, in cooperation with the stockmen, the manner by which the best results will be secured both from a business and range standpoint. As a rule the best range management is the best business practice. If the range is conservatively stocked so that full forage production will continue, with correct seasonal use and uniform utilization of the whole range, success of the business is promoted. When the range is overgrazed as a whole or when indifferent or poor management results in overgrazing some areas and leaving others untouched, the user pays the penalty in decreased returns and all the attendant evils of range abuse occur. Good management of ranges is not a mere theory, but a fact demonstrated by practical application on some range in every national forest on which livestock graze.

The elimination of bad practices is the goal of the Forest Service. In striving to reach this goal, however, long-standing prejudices and opinions must be encountered. In some cases these lead to an accusation of arbitrary and bureaucratic requirements when the regulatory measures are imposed that are necessary to keep national-forest land fully productive and to insure the greatest net public benefit in timber, game, and livestock production and in watershed protection. To redeem its responsibilities under the law, however, the Forest Service must require observance of these measures.

The question has been raised whether the regulations and range management practices are, after all, adapted to ranges where timber production and watershed protection are not involved. The regulations and practices are the outcome of 25 years of experience, experimentation, and practical trial and test on all kinds of land. They are flexible, permitting the kind of management the specific land resources dictate. In other words, the values represented and their requirements are the governing factors. On most of the national-forest ranges it is true that more than one resource is involved and that management of the land must involve plans for the best correlated use. On the other hand, forage may be the dominant, if not the only, resource. Where this is the case its protection and use forms the main or sole foundation for the plans and practices.

RANGE IMPROVEMENTS

Previous reports have stressed the need of range improvements and furnished examples of their relation to good administration. Increased appropriations during the past few years have aided greatly in providing the most needed improvements. Nevertheless, as shown in Table 16, the estimated cost to the Government of those still awaiting construction virtually equals the expenditures to date. Continued progress is essential to efficient range use.

TABLE 16.—*Range improvements constructed and needed on national forests to December 31, 1929*

RANGE IMPROVEMENTS CONSTRUCTED

Type of improvement	National forest region						Total
	1	2	3	4	5	6	
Boundary and drift fences.....miles..	416	1,002	6,041	642	1,967	723	10,791
Water development.....number..	319	400	2,969	992	548	373	5,601
Driveways.....miles..	1,087	1,324	-----	626	7	910	3,954
Bridges.....number..	25	20	17	26	-----	13	101
Trails.....miles..	1	-----	-----	117	-----	8	126
Corrals.....number..	68	77	30	73	5	115	368
Cabins.....do..	36	-----	-----	-----	-----	55	91
Pastures.....do..	15	-----	-----	-----	1	-----	16
Poison eradication.....acres..	95	11,036	230	3,177	881	29	15,448
Salt troughs.....number..	2	-----	-----	-----	-----	1,250	1,252
Cost to stockmen.....dollars..	91,685	91,911	2,358,184	165,484	156,275	164,373	3,027,912
Cost to Government.....do..	201,707	147,079	245,119	121,413	91,526	68,178	875,022
Total cost.....do..	293,392	238,990	2,603,303	286,897	247,801	232,551	3,902,934

RANGE IMPROVEMENTS NEEDED

Boundary and drift fences.....miles..	233	231	3,696	376	142	1,674	6,352
Water development.....number..	340	167	892	765	419	662	3,245
Driveways.....miles..	-----	87	-----	166	10	390	653
Bridges.....number..	-----	2	1	30	-----	5	38
Trails.....miles..	-----	-----	90	161	-----	5	256
Corrals.....number..	-----	7	119	9	-----	219	354
Cabins.....do..	-----	-----	-----	-----	-----	102	102
Pastures.....do..	-----	-----	-----	-----	19	9	28
Poison eradication.....acres..	4,645	4,383	250,971	6,594	490	809	267,892
Salt troughs.....number..	-----	-----	-----	-----	-----	1,937	1,937
Cost to stockmen.....dollars..	765	23,728	221,651	126,439	4,272	324,918	701,773
Cost to Government.....do..	108,535	77,046	382,712	142,580	76,725	84,272	871,870
Total cost.....do..	109,300	100,774	604,363	269,019	80,997	409,190	1,573,643

GRAZING TRESPASS

The number of grazing trespass cases has gradually declined for several years but there are still too many. Better observance of the regulations will enable local forest officers to divert the time and effort expended on trespass to more productive channels. The impounding regulation continues to play an important part in eliminating trespassing animals from national-forest range, and since its validity was upheld by court decision it will be more universally applied.

Table 17 shows the losses of livestock during 1929 on the national forests from all causes. The losses of cattle due to poisonous plants decreased over 4 per cent, but sheep losses showed an apparent increase of over 5 per cent. In part this was because more complete data were obtained than for the previous year, but in part was due to weather conditions.

There is great need of more knowledge of varying plant toxicity, the chemical constituents of the plants as related to requirements of range animals, and the place of supplemental feeds and salt in supplying any nutritional deficiencies. Each poisonous plant presents a special problem, and its control depends upon basic information obtainable only through research. Over half the loss of cattle is caused by larkspur poisoning, a plant for which control methods have been fairly well worked out and are being applied on national-forest range. The value of all animals lost in 1929 from poisonous plants, over \$600,000, illustrates the importance of further study and increased prevention.

The losses due to predatory animals and other causes were slightly less than in 1928. The effective work of the Bureau of Biological Survey in control of predatory animals is no doubt reflected in this decrease. Such an enlarged program as is now before Congress for this control work is urgently needed. It is estimated that the loss of game from predatory animals is over one and one-half times the number killed annually by hunters.

TABLE 17.—*Livestock losses, 1929*

CATTLE AND HORSES

Region	Stock lost from all poisonous plants, including larkspur		Stock lost from predatory animals and other causes exclusive of poisonous plants		Total stock lost, all causes	
	Number	Value	Number	Value	Number	Value
1.....	237	\$15,800	559	\$37,265	796	\$53,065
2.....	2,114	140,935	2,029	135,265	4,143	276,200
3.....	694	46,265	2,730	182,000	3,424	228,265
4.....	2,053	136,865	1,502	100,135	3,555	237,000
5.....	626	41,735	889	59,265	1,515	101,000
6.....	239	15,935	556	37,065	795	53,000
Total.....	5,963	397,535	8,265	550,995	14,228	948,530

SHEEP AND GOATS

1.....	2,218	\$22,180	17,397	\$173,970	19,615	\$196,150
2.....	4,915	49,150	19,314	193,140	24,229	242,290
3.....	2,063	20,630	5,124	51,240	7,187	71,870
4.....	10,191	101,910	39,241	392,410	49,432	494,320
5.....	1,674	16,740	6,856	68,560	8,530	85,300
6.....	2,822	28,220	12,704	127,040	15,526	155,260
Total.....	23,883	238,830	100,636	1,006,360	124,519	1,245,190

RECREATION AND GAME

The estimated number of persons visiting the national forests in 1929 was 31,758,231, which was greater by 38 per cent than in the preceding year and more than ten times greater than in 1917. Specifically, the estimates included 376,780 special-use permittees and their guests, 1,795,861 hotel and resort guests, 1,902,961 campers, 3,056,456 picnickers, and 24,626,173 transient motorists. Inevitably these estimates involve certain duplications, since the same person may visit and be counted in several different forests or the same forest several different times in the year; their chief significance is for year-to-year comparisons, for which they are approximately accurate.

During the year 307 additional public camp grounds were at least partially equipped with facilities essential to public health and convenience and the protection of public property. The total number of national-forest camp grounds now wholly or partly improved is 1,493. Many additional facilities must be installed before these areas will adequately provide the safeguards to public health and property necessitated by the presence of many millions of people within the national forests during the periods of greatest fire danger. Expenditures for camp-ground improvement during 1929 totaled \$51,086. The entire cost of the existing system of camp grounds has been \$329,922, of which \$48,642 was contributed by public or private cooperators in cash, materials, or labor.

Many communities established originally on the bases of timber, forage, mineral, or agricultural resources now either depleted or inadequate to sustain modern standards of life have been able to maintain or enlarge their incomes through various forms of service to the millions who visit the national forests, and have thus become economically dependent upon the recreation and game resources of the forests. In consequence, these resources have assumed a new economic importance, frequently ranking with and in some cases outranking other natural resources. The proper conservation and development of the recreation and game resources, therefore, is regarded as a distinct obligation by the Forest Service. Much which markedly will enhance the value and service of these resources and promote the growth and progress of dependent communities can be accomplished by more intensive planning, development, and management of outstanding areas. It would be good national economy to meet the cost of such work.

During the year the study of the Mount Hood area, in Oregon, by the special committee appointed by the Secretary of Agriculture was completed, and the findings of the committee were summarized in a report in many respects epochal in its suggestion of new principles and policies for the management of such areas. The report has been printed as Senate Document No. 164, Seventy-first Congress, second session. At the close of the year a partial application of the committee's recommendations was under way, and it is hoped eventually to carry out the program substantially as outlined.

Table 18 shows the estimated number of big-game animals and beaver on the national forests. During the last five years the esti-

mated number of antelope has increased 35 per cent, of black or brown bear 9 per cent, of deer 32 per cent, of elk 15 per cent, of mountain goats 18 per cent, and of mountain sheep 2 per cent, with decreases of 37 per cent in grizzlies, 86 per cent in caribou, and 15 per cent in moose. Unless more protection is afforded the grizzly other States will be in the class of California, where this wonderful animal is now extinct. The decrease in caribou is due largely to the disappearance of the herd on one forest adjoining Canada, and it is assumed the herd has shifted its range to Canada. More reliable estimates may be and probably are responsible for the apparent lower number of moose.

TABLE 18.—*Number of big-game animals and beaver on national forests, by States, estimated as of December 31, 1929*

State	Antelope	Bear		Caribou	Deer	Elk	Moose	Mountain goat	Mountain sheep	Beaver
		Black or brown	Grizzly							
Alaska.....		¹ 5,710	² 2,600	20	62,400	12	560	10,000	1,000	4,000
Alabama.....					250					
Arizona.....	3,929	534	5		84,832	1,070			274	395
Arkansas.....		3			1,530					
California.....	900	11,400			254,475	193			690	225
Colorado.....	110	2,641	13		33,315	10,286		12	3,374	40,123
Florida.....		37			775					6
Idaho.....	2,585	5,603	135		62,288	8,828	635	3,195	1,512	15,579
Montana.....	537	5,646	523		51,890	12,958	1,363	4,283	2,140	17,051
Nebraska.....					75				5	
New Hampshire.....		830			3,200					
New Mexico.....	1,000	789	14		57,785	319			175	1,345
Nevada.....	190				6,440				145	275
North Carolina.....		145			4,852	51				
Oklahoma.....	9	4			325	375				
Oregon.....	159	5,564			81,455	7,699	2		50	3,712
Pennsylvania.....		200			3,000	10				60
South Dakota.....	390				5,060	321				1,585
Tennessee.....		22			148					
Utah.....		466	8		45,729	2,648			134	3,000
Virginia.....		700			110	75				
Washington.....		8,325	19		28,598	9,099		3,560		10,495
West Virginia.....		250			17					
Wyoming.....	410	1,795	190		13,910	28,728	2,594		2,829	8,811
Total.....	10,219	50,664	3,507	20	802,459	82,672	5,154	21,050	12,328	106,662

¹ Black bear only.

² Includes Alaska brown bear.

It is important that the national-forest wild-life resource have careful study, planning, and administration. The national forests constitute the largest and best big-game grounds in the country. They are maintained at public expense for the use and benefit of all the people. Unlike the private game preserves, they keep open for the everyday American opportunities for the enjoyment of sport and recreation which in European countries are restricted to the privileged few. They should be so administered as to combine a democratic system of use with scientific game propagation and management. This requires a coordination of Federal and State action, based on a clear understanding of the problems involved, and a common purpose. Wherever through game production the principle of

highest and fullest use of the national forests can be served, game-management plans are needed.

These plans are based on facts obtained through studies conducted by the Bureau of Biological Survey and through the observations of local forest officers. The essentials are to determine the kinds of game to which each individual area is adapted, the number of animals it will support, the number that may be removed each year while still maintaining an adequate breeding stock, the season when hunting may be permitted without undue disturbance or injury to the herd, and the needs of other resources. Since the protective phases of game administration are governed by State laws, it is fundamental that these laws be based on the best knowledge, and that they be well designed. The problems of game management are sufficiently important to employ the combined resources both of the State and of the Federal agencies concerned, and cooperative relationships are not only desirable but imperative if the best results are to be attained. The objectives are the same and the combined efforts of all available agencies will be none too great to keep our lands and streams fully productive of game and fish.

Forest officers assisted in State law enforcement as indicated in Table 19.

TABLE 19.—Game protection by forest officers, 1929

State	Cases reported to State for prosecution	Convictions secured	Cases reported to State for investigation	Convictions secured	Cases handled by forest officers			Total number of violations	Licenses issued by forest officers	Licenses examined by forest officers
					Dismissed with warning	Arrests by forest officers	Convictions secured			
Arizona.....	20	17	16	9	9	10	7	56	86	4, 717
California.....	75	48	88	22	18	16	14	197	1, 810	16, 228
Colorado.....	48	34	21	4	20	1	1	90	---	2, 336
Idaho.....	28	10	34	17	9	33	25	104	760	2, 611
Montana.....	---	---	---	---	---	26	25	26	516	3, 124
Nevada.....	---	---	---	---	---	---	---	---	38	200
New Mexico.....	8	5	---	---	15	19	15	42	---	1, 883
Oklahoma.....	2	2	15	2	---	1	1	18	---	10
Oregon.....	30	20	111	23	1	14	4	156	10	748
South Dakota.....	1	1	2	---	1	---	---	4	66	28
Utah.....	12	6	12	3	4	3	2	31	639	3, 273
Washington.....	11	6	6	---	4	1	1	22	206	859
Wyoming.....	13	7	27	6	1	19	19	60	422	2, 048
Total.....	248	156	332	86	82	143	114	806	4, 553	38, 065

Last year's report stated that the national forests contain over 100 State game refuges. Actually there are 258 State refuges on over 100 forests. They are in 20 different States and cover 19,652,580 acres. The largest number is in New Mexico, but the largest acreage is in Idaho. Table 20 presents further details.

TABLE 20.—*Game refuges on national forests, December 31, 1929*

State	State game refuges		Federal game preserves		Game areas by administrative restrictions	
	Number	Acreage inside forest	Number	Acreage inside forest	Number	Acreage
Alabama.....	1	16, 000				
Alaska.....			1	140, 681		
Arizona.....	23	1, 102, 601	2	793, 377		
Arkansas.....			5	21, 500		
California.....	31	2, 034, 853	3	48, 343	2	19, 800
Colorado.....	18	2, 666, 484			24	202, 607
Florida.....	1	60, 000				
Georgia.....			1	14, 000		
Idaho.....	20	3, 033, 578			8	644, 818
Montana.....	19	1, 213, 831			42	573, 030
Nebraska.....	1	206, 026				
Nevada.....	10	1, 155, 282				
New Hampshire.....	3	7, 960				
New Mexico.....	55	1, 134, 127	1	45, 515		
North Carolina.....	2	31, 010	1	98, 381		
Oklahoma.....			1	60, 800		
Oregon.....	11	735, 226			2	166, 600
Pennsylvania.....	2	17, 860				
South Dakota.....	2	26, 060	2	49, 908		
Tennessee.....			1	30, 000		
Utah.....	10	1, 157, 526			1	5, 000
Virginia.....	5	7, 200				
Washington.....	24	2, 284, 058			1	13, 517
West Virginia.....	2	23, 000				
Wyoming.....	18	2, 739, 898	2	84, 450	7	114, 900
Total.....	258	19, 652, 580	20	1, 386, 955	87	1, 740, 272

The average size per refuge varies widely among States. In most instances the refuges first established were large. The generally accepted principle now, however, is that many small refuges are better than a few large ones. Many State refuges are entirely too large to serve the purposes intended advantageously. Although readjustments are urgently required, they are difficult to secure, since in most cases they necessitate changing State laws. Immediate remedial action is imperatively needed, especially on those refuges now overstocked with big-game animals, where overgrazing is occurring.

Cooperation is greatly aided wherever States place broad regulatory powers in the hands of a qualified nonpolitical State fish and game commission, with authority to regulate the opening and closing of game refuges and other areas as well as to establish seasons, bag limits, etc., in accordance with the particular requirements of each locality. Game administration should be based on facts rather than sentiment. The difficult problem that formerly existed in Arizona is now being worked out with the State commission along cooperative lines and without confusion, controversy, or misunderstanding. In fact, the adoption by Arizona of its new game code was one of the most progressive steps in game administration ever taken by any State. That code is based on logic, good common sense, and scientific facts.

Critical game-refuge situations due to overstocking exist in New Mexico, Idaho, Montana, Utah, Arizona, and Wyoming, and similar situations in other States seem inevitable. It is hoped that remedial measures may be applicable before injury to the herds, range, and other resources becomes too serious.

Federal preserves or refuges established on the national forests by specific acts of Congress afford adequate protection where public sentiment is indifferent and State laws ineffective, or where a particular species of game animal or bird is approaching extinction and its preservation is of national importance. They also serve as demonstrational and experimental areas on which research may be conducted and the results applied in a scientific manner. The Grand Canyon game preserve, on the Kaibab Forest, has afforded a striking illustration of the problems of game administration connected with the need to limit the number of animals to the productive capacity of the area and to provide a workable system for removing any surplus. Regulated hunting in all that the term implies has been established on this preserve, affording the first instance of such regulation in the history of American public administration of game areas. One notable fact is that during the past five years 5,261 hunters have occupied the area without a fatality and with only one accident.

WATER POWER

On June 30, 1930, 253 water-power permits or easements issued by the Department of Agriculture were outstanding, of which 171 require the payment of an annual rental, while 82 are free permits. Fifty-eight of the rental permits or easements and 60 of the free permits are for power projects, with an estimated average output at minimum discharge of 515,565 horsepower for the rental permits and of 25,970 horsepower for the free. Permits or easements involving transmission lines only included 113 rental, with a length of 929.22 miles of line within the forest boundaries, and 22 free, with a length of 155.40 miles.

The Federal water power act, approved June 10, 1920, provided that the work of the Federal Power Commission shall be performed by and through the Departments of War, Interior, and Agriculture, and their engineering, technical, clerical, and other personnel, except as may otherwise be provided by law. Under this provision the Forest Service, with its own personnel, has done a very large amount of field engineering and supervision work for the commission. At the request of the commission the Forest Service was supervising at the close of the fiscal year the operations of 332 permittees or licensees, a net increase of 37. During the year the commission requested field investigations and reports in 70 cases of application for permit or license. The Forest Service reported on 61 cases and also made several valuations and appraisals. Of the 102 projects for which application was received by the commission during the year 56 involved the use of national-forest land. The regional foresters issued 13 permits for projects of 40 horsepower or less and for periods not exceeding 10 years.

The new Federal water power act of June 23, 1930, provides for a commission of five, to be appointed by the President. The commis-

sion is authorized to employ such engineers, accountants, legal advisers, and other officers and employees as are necessary in the execution of its functions. At the request of the commission the Forest Service has handled valuation and accounting work on certain cases. Prior to December 12, 1929, nearly all of these cases concerned relatively small investments, but in accordance with the commission's request of that date the Forest Service is now assisting on some 10 or more important and difficult cases. Participation in the engineering investigations and reports and supervision of the operations of permittees and licensees is of decided value to the Forest Service in its administration of national-forest lands and resources. Assistance in handling the commission's valuation and accounting work is gladly given whenever the Forest Service can effectively aid without sacrificing national-forest work unduly.

The aerial photographic survey of southeastern Alaska was completed by the Alaskan aerial survey detachment, representing cooperation between the Navy, the Department of the Interior, and the Department of Agriculture. During the season 13,000 square miles were covered. The method consisted of dividing the region into suitably sized blocks and then gridironing each with airplane flights at an elevation of 10,900 feet. Thus a series of vertical photographs has been obtained, which furnishes new information on the topography and natural resources of the entire area of southeastern Alaska. The results are of special value to the Forest Service and the Federal Power Commission, since the Tongass National Forest has large bodies of timber and water-power resources awaiting development.

ROADS

Tables 21 to 25 show the forest road and trail situation at the close of the fiscal year. Three classes of construction are differentiated: Forest highways, which form part of the public road system and are of primary value for general public use; forest-development roads, of which the primary value is to provide the communication and transportation facilities necessary for the use, development, and protection of national-forest resources; and trails, which serve chiefly protection needs. All three classes coordinate in providing a comprehensive system of national-forest roads and trails requisite both for administration and for public convenience and local community development. For efficiency a due balance of the three classes is essential.

TABLE 21.—*Classification of mileage in forest road and trail system and expenditures required to complete system to satisfactory standard*

Class	Total	Satisfactory standard	Unsatisfactory standard	Non-existing	Expenditures required to complete
	<i>Miles</i>	<i>Miles</i>	<i>Miles</i>	<i>Miles</i>	<i>Dollars</i>
Forest highways.....	16, 023	7, 307	7, 410	1, 306	166, 097, 400
Forest-development roads.....	51, 703	20, 048	14, 382	17, 273	60, 497, 200
Trails.....	149, 768	103, 489	9, 730	36, 549	5, 993, 600
Total.....					232, 588, 200

TABLE 22.—Construction, improvement, and maintenance of roads and trails from forest-road appropriations and other Federal and cooperative funds, by States, June 30, 1930

State	Fiscal year 1930				Total constructed to June 30, 1930		Expenditure to June 30, 1930		
	Constructed		Maintained		Roads	Trails	Federal funds	Cooperative funds	Total funds
	Roads	Trails	Roads	Trails					
	Miles	Miles	Miles	Miles	Miles	Miles	Dollars	Dollars	Dollars
Alabama			111.5		102.5		100,912.03	25,278.16	126,190.19
Alaska	9.3	42.0	213.5	179.0	227.1	398.5	4,658,760.90	324,256.08	4,983,016.98
Arizona	180.9	58.0	1,220.5	1,069.5	1,522.3	1,641.0	5,510,128.46	864,100.40	6,374,228.86
Arkansas	59.0		247.0	150.0	476.5	518.9	1,070,608.02	29,638.14	1,100,246.16
California	515.3	447.0	4,120.2	6,795.8	2,544.9	3,546.6	13,546,717.93	5,259,499.07	18,806,217.00
Colorado	140.3	292.6	871.7	9,031.4	1,413.1	4,644.9	6,471,675.92	902,116.68	7,373,792.60
Florida	38.0		192.0		248.9		375,774.79	136,411.18	512,185.97
Georgia	9.9	22.0	142.0	190.6	71.5	212.6	412,562.46	53,819.64	466,382.10
Idaho	155.5	1,586.7	1,772.4	9,799.0	2,042.0	12,167.1	13,410,754.27	1,729,770.88	15,140,525.15
Illinois							420.57		420.57
Kansas					3.4		2,111.51		2,111.51
Kentucky							808.72		808.72
Maine		5.0	5.3	40.8	5.3	45.8	41,531.45		41,531.45
Maryland							70.05		70.05
Michigan	2.8		43.3		34.0		74,713.36	394.93	75,108.29
Minnesota	10.4	7.7	119.0	347.6	363.0	146.8	748,342.88	255,768.27	1,004,111.15
Montana	52.4	1,406.9	1,391.3	10,380.0	992.8	6,823.2	8,164,141.32	625,539.16	8,789,680.48
Nebraska	1.4		53.1		48.3		86,477.64	990.80	87,468.44
Nevada	24.6	22.6	189.3	86.0	454.1	853.6	1,376,581.49	153,574.55	1,530,156.04
New Hampshire	5.6	8.0	43.9	438.0	48.2	446.0	295,658.20	18,474.83	314,133.03
New Jersey							217.71		217.71
New Mexico	107.9	47.8	630.2	1,238.0	885.8	1,492.1	3,986,090.79	324,825.74	4,310,916.53
New York							81.32		81.32
North Carolina	9.2	8.5	182.2	596.2	205.7	613.0	679,883.44	62,857.41	742,740.85
North Dakota					1.0		57.75		57.75
Oklahoma			35.0		24.7	16.5	55,933.11	12,362.16	68,295.27
Oregon	230.0	868.9	5,416.4	10,096.5	3,028.6	6,979.7	12,448,808.55	5,958,014.12	18,406,822.67
Pennsylvania	.2		129.8		47.2		97,012.22	3,381.92	100,394.14
Porto Rico				36.0	4.6	36.3	18,127.41	550.00	18,677.41
South Carolina	1.0		17.9	4.0	17.3	18.2	97,755.73	15,659.81	113,415.54
South Dakota	14.6	10.0	142.3	28.6	287.3	71.7	805,238.54	222,846.11	1,028,084.65
Tennessee		38.0	63.8	542.9	93.1	574.9	395,848.80	136,369.34	532,218.14
Utah	39.9	143.8	682.5	931.7	1,066.3	3,448.3	3,377,621.44	787,778.56	4,165,400.00
Virginia	3.0	9.0	147.6	564.2	113.4	780.2	540,041.29	39,944.90	579,986.19
Washington	77.7	970.2	1,006.6	8,452.0	1,029.4	5,430.1	8,020,935.63	1,574,655.35	9,595,590.98
West Virginia	19.0	18.0	87.3	266.2	78.0	343.7	185,547.80	5,300.00	190,847.80
Wyoming	17.7	162.8	620.1	4,521.1	974.4	2,202.8	4,217,175.06	380,564.32	4,597,739.38
Total	1,725.66	6,175.5	19,897.7	65,785.1	18,454.7	53,452.5	91,275,128.54	19,904,742.51	111,179,871.07

TABLE 23.—Distribution among the States of the apportionments for the fiscal year 1931

State	10 per cent fund	Forest high-way fund	Forest-road development fund	Total
	Dollars	Dollars	Dollars	Dollars
Alabama	76.21	7,558	12,178	19,812.21
Alaska	11,030.75	969,811	18,992	999,833.75
Arizona	36,832.95	599,307	151,175	787,314.95
Arkansas	22,978.35	89,146	80,214	192,338.35
California	162,750.81	1,428,063	478,859	2,069,672.81
Colorado	56,496.96	692,324	117,253	866,073.96
Florida	4,592.59	28,572	14,581	47,745.59
Georgia	1,602.11	16,570	28,873	47,045.11
Idaho	66,208.48	1,036,524	659,903	1,762,635.48
Illinois		823		823.00
Maine	729.16	2,880	2,250	5,859.16
Michigan	738.04	14,820	7,181	22,739.04
Minnesota	4,936.02	63,078	14,780	82,794.02
Montana	30,477.55	837,355	251,377	1,119,209.55

TABLE 23.—*Distribution among the States of the apportionments for the fiscal year 1931—Continued*

State	10 per cent fund	Forest high-way fund	Forest-road development fund	Total
	<i>Dollars</i>	<i>Dollars</i>	<i>Dollars</i>	<i>Dollars</i>
Nebraska.....	950.02	9,817	896	11,663.02
Nevada.....	10,500.19	198,858	14,539	223,897.19
New Hampshire.....	10,041.32	45,171	12,387	67,599.32
New Mexico.....	14,101.15	425,414	101,658	541,173.15
North Carolina.....	4,029.62	27,271	30,762	62,062.62
Oklahoma.....	844.03	4,176	2,703	7,723.03
Oregon.....	76,709.06	1,334,195	433,282	1,844,186.06
Pennsylvania.....	1,521.92	16,906	20,979	39,406.92
Porto Rico.....	65.91	1,123	1,180	2,368.91
South Carolina.....	596.17	3,184	1,857	5,637.17
South Dakota.....	17,679.06	83,581	12,131	113,391.06
Tennessee.....	1,386.87	25,175	23,717	50,278.87
Utah.....	23,122.47	350,105	54,053	427,280.47
Virginia.....	4,923.59	31,846	33,051	69,820.59
Washington.....	66,576.44	699,555	278,799	1,044,930.44
West Virginia.....	994.21	14,809	23,350	39,153.21
Wyoming.....	37,531.71	441,983	117,040	596,554.71
Total.....	671,023.72	9,500,000	3,000,000	13,171,023.72

TABLE 24.—*Distribution among the States of the total apportionments, including the fiscal year 1931*

State	10 per cent fund	Section 8 fund	Federal forest road construction	Forest high-ways	Forest road development	Total
	<i>Dollars</i>	<i>Dollars</i>	<i>Dollars</i>	<i>Dollars</i>	<i>Dollars</i>	<i>Dollars</i>
Alabama.....	884.22	15,456.04	1,922.31	35,369.00	68,113.00	121,744.57
Alaska.....	161,434.78	470,698.56	193,549.95	4,999,636.00	218,511.00	6,043,830.29
Arizona.....	606,189.43	680,092.81	501,984.55	3,035,843.00	1,349,332.00	6,173,441.79
Arkansas.....	122,305.46	174,939.40	128,773.38	392,693.00	488,432.00	1,307,143.24
California.....	1,516,831.67	1,466,656.22	1,206,815.23	7,349,937.00	4,042,207.00	15,582,447.12
Colorado.....	699,320.03	760,086.53	777,307.26	3,602,133.00	1,563,281.00	7,402,127.82
Florida.....	38,485.82	119,528.14	21,534.94	127,869.00	135,592.00	443,009.90
Georgia.....	11,349.52	52,393.57	134,387.16	88,303.00	171,309.00	457,742.25
Idaho.....	911,429.93	1,198,282.93	1,367,402.82	5,455,404.00	6,088,418.00	15,020,937.68
Illinois.....				2,379.00	396.00	2,775.00
Kansas.....	1,867.27					1,867.27
Kentucky.....	722.72				86.00	808.72
Maine.....	3,498.69	32.41	3,738.77	14,112.00	24,134.00	45,515.87
Maryland.....	70.05					70.05
Michigan.....	3,428.77	115.63	3,000.00	36,277.00	64,299.00	107,120.40
Minnesota.....	39,298.67	8,292.73	108,352.03	317,931.00	340,898.00	814,772.43
Montana.....	571,475.62	756,615.09	731,497.39	4,355,605.00	3,051,648.00	9,466,841.10
Nebraska.....	18,563.94	18.98		52,618.00	28,747.00	99,947.92
Nevada.....	167,880.26	195,073.18	82,265.33	1,037,786.00	132,424.00	1,615,428.77
New Hampshire.....	46,220.61	341.66	10,941.30	193,232.00	137,563.00	388,298.57
New Jersey.....	118.99				83.00	201.99
New Mexico.....	339,260.05	430,479.61	509,215.36	2,258,910.00	1,060,980.00	4,598,845.02
New York.....	4.00				20.00	24.00
North Carolina.....	35,813.77	84,733.83	176,890.28	142,577.00	285,928.00	725,942.88
North Dakota.....	45.75	7.00				52.75
Oklahoma.....	9,816.47	65.49	2,775.17	24,526.00	25,223.00	62,406.13
Oregon.....	986,004.95	1,431,759.62	1,077,552.29	6,395,826.00	4,430,743.00	14,321,885.86
Pennsylvania.....	3,393.75	24.04	21.42	46,918.00	90,766.00	141,123.21
Porto Rico.....	94.60	7.00	3,343.09	6,533.00	13,128.00	23,105.69
South Carolina.....	2,826.55	402.10	48,028.61	15,413.00	45,599.00	112,269.26
South Dakota.....	171,369.92	83,752.10	79,341.53	400,856.00	197,367.00	932,686.55
Tennessee.....	18,564.11	103,433.37	28,092.79	115,326.00	198,999.00	464,415.27
Utah.....	384,172.45	445,941.81	464,562.35	1,845,252.00	625,474.00	3,765,402.61
Virginia.....	43,739.90	58,390.16	71,902.26	158,810.00	278,393.00	611,235.32
Washington.....	614,436.90	939,812.13	712,201.40	3,571,967.00	3,134,615.00	8,973,032.43
West Virginia.....	5,796.79	12,830.41	5,049.24	55,620.00	149,865.00	229,161.44
Wyoming.....	417,318.40	472,109.76	547,551.79	2,364,339.00	1,057,427.00	4,858,745.95
Undistributed.....		37,627.69				37,627.69
Total.....	7,954,034.81	10,000,000.00	9,000,000.00	48,500,000.00	29,500,000.00	104,954,034.81

TABLE 25.—*Condition of forest-road funds on June 30, 1930*

Fund	Appropriations	Expenditures	Unexpended balance
10 per cent.....	\$7, 283, 011. 09	\$6, 836, 337. 65	\$446, 673. 44
Sec. 8.....	10, 000, 000. 00	9, 917, 125. 58	82, 874. 42
Federal forest-road construction.....	9, 000, 000. 00	9, 000, 000. 00	
Forest highway.....	39, 000, 000. 00	37, 233, 992. 69	1, 766, 007. 31
Forest road development.....	26, 500, 000. 00	26, 134, 739. 33	365, 260. 67
Total.....	91, 783, 011. 09	89, 122, 195. 25	2, 660, 815. 84

In addition to the regulation trail, for which definite standards of width, permissible grade, and other structural features have been established, simpler pathways, commonly designated "ways," have recently become a recognized part of the protective roads system.

Road funds are partly Federal, partly cooperative. Of the Federal funds the principal part is provided by specific acts of Congress making appropriations for nation-wide road development. There is also, under a continuing provision of law, the so-called "10 per cent fund," comprising 10 per cent of the national-forest receipts for the preceding year.

The Federal legislation for a program of nation-wide road development has recognized a need for special provisions relating to national-forest roads, along two distinct lines. Because the national forests withhold from taxation extensive land areas and resources, a counterbalancing increase of appropriations for development of those portions of the general public road system traversing the forests has become customary; and in addition the appropriation acts have carried a separate item for the construction and maintenance of the supplementing forest-development road and trail system.

The act of June 24, 1930, for national-forest roads and trails raised the appropriation authorization for the fiscal year 1931 from \$7,500,000 previously authorized to \$12,500,000 and set up this authorization for the years 1932 and 1933. Under the earlier legislation the \$7,500,000 was divided on a 60-40 ratio between the forest highway system and the forest-development road system. Under the provisions of the new law, however, all the \$5,000,000 increase will be added to the former provision of \$4,500,000 for national-forest roads embraced in the forest highway system, leaving unaltered the \$3,000,000 previously provided for forest-development roads. While this will decidedly speed up the rate of progress toward completion of the forest highway system, it leaves the roads of the second class less well provided for. These roads are of decided value to the local public and an indispensable tool for efficient protection, administration, and development of the forest resources.

The act of June 24, 1930, prescribed as conditions to the expenditure of more than \$7,500,000 under the 1931, 1932, and 1933 authorizations: (1) That the Secretary of Agriculture shall give preference to projects which he shall determine are not otherwise satisfactorily financed or provided for, located on the Federal-highway system as now or hereafter designated; (2) that the projects so preferred shall be constructed of the same width and character as the Federal Government requires of the States under like conditions; and (3) that the Secretary of Agriculture shall prepare, publish, and distribute a

map and other information, at least annually, showing the progress made in the expenditure of the amounts exceeding \$7,500,000.

In last year's report mention was made of a new method of determining the most advantageous and economical transportation system required for protection. During the year the planning of the systems for several individual forests was undertaken, and within four years the completion of such plans for all forests where they are called for is contemplated. The objective is to enable fire fighters to reach any fire within a certain time, this time being determined by the value of the resources exposed to fire damage, the degree of hazard, and the consequent rapidity of action deemed necessary to hold losses inside a specified limit.

It is recognized that the complete prevention of fire damage is impossible. Many fires will start and will cover at least some ground before they can be discovered, reported, and extinguished. Other things being equal, the area covered will depend upon how quickly an adequate force of fire fighters with adequate equipment can reach them. The importance of prompt control, however, varies both with the value of the resources exposed to fire damage and with the degree of exposure. A rational system of protection must take these variables into account in setting up standards of satisfactory performance or objectives. Once this objective is established the transportation system can be planned with a view to obtaining at the least annual expense, the prescribed degree of promptness of control and the number and location of the protective force required to make possible reaching, in the allowable travel time, a fire anywhere within the protection unit for which the plan is made.

The first dependence for fire suppression is the "smoke chaser," or the single-man outfit, highly mobile and prepared to start instantly on receipt of the alarm. When 1-man control is judged to be improbable or proves to be impossible, larger crews must be gathered and dispatched. The planned system must meet the travel-time requirements of both "first-line defense" and "second-line defense." Usually there are several possible arrangements of roads, trails, ways, and men that will satisfy the specific requirements laid down—for example, a large number of smoke chasers, practically no roads, and not many trails and ways; or fewer men, a large mileage of trails and ways, and a small mileage of roads; or a few widely scattered smoke chasers, a comparatively small mileage of trails and ways, and a large mileage of roads, some of high duty. To determine which system will give the desired results at the least annual cost requires careful study. Annual cost is the cost of maintenance plus an interest allowance on the expenditure for construction. It is usually necessary to design for the second-line defense and modify or add to meet the requirements for first-line defense.

Where portions of the area can be reached within the prescribed travel time from two or more stations, the annual cost of the system is raised. If reaching all parts of the area in the specified time involves—as is nearly always the case—such overlapping, the question arises whether the cost of the overlap is justified, or whether part of the area should have less protection.

Developing a transportation plan is costly in time, including much field work, but when completed these plans promise to have great value. By indicating the required organization and its location they

will show where buildings, telephone lines, and other improvements of an administrative and protective nature should be placed. They will also help determine the best layout of ranger districts and will afford a guide to the most effective use of road and trail appropriations through orderly construction based on recognition of the relative importance of projects. Still more important, before the construction of a road or trail is begun the duty or service which it must render to fulfill the protection objective will be definitely known. If a road is needed on which 30 miles can be traveled in two hours the transportation planning provides one requiring neither more time nor less, unless one requiring less time can be constructed without augmenting annual costs.

The same type of construction will not always provide the same travel rate, nor cost the same, either for construction or annually. On the contrary, the cost of securing a desired speed varies greatly. Under favorable conditions it may be only a fraction of that under unfavorable. To design a road that will make available the desired speed at the lowest annual cost, knowledge is needed of the speed obtainable with various combinations of the several elements that make up a road standard. To secure the required data necessitates setting up special tests. The effect of banking and curvature on speed of travel has been determined, and partial data have been secured on the effect of gradient and surface condition.

MAPS AND SURVEYS

The Forest Service published during the year for administrative use 13 national-forest maps on a scale of one-fourth inch to the mile; 12 on a scale of one-half inch to the mile, of which 3 were lithographed in several colors; and 3 on the scale of 1 inch to the mile, of which 1 was an atlas folio. Three administrative maps on odd scales were published and 10 proclamation diagrams were issued in cooperation with the Department of State.

Twenty-one maps of forests, 77 atlas pages, and 1 atlas page showing culture, drainage, and contours were compiled, revised, or traced; 2,030 type maps and atlas pages were colored; and 368 graphs showing research data were compiled. In addition, numerous posters, ranger maps, status and ownership maps, organization charts, working circle maps, recreation or folder maps, index maps, road signs and maps, mechanical drawings, panels for exhibition purposes, etc., were prepared by the draftsmen.

Topographic and drainage surveys of considerable areas were made upon the Kootenai, Shasta, Powell, Boise, and Dixie Forests. Topographic surveys were also made of many small timber, grazing, and land-exchange areas.

The General Land Office initiated original surveys within the national forests on 43 townships and completed the survey upon 36. Resurveys were initiated upon 20 townships; and surveys, some of which had been started during the previous year, were completed upon 23. The total area which was surveyed or resurveyed amounted to approximately 900,000 acres.

The Geological Survey surveyed approximately 2,100 square miles of national-forest land.

The photographic laboratory turned out 5,911 lantern slides, 92,781 square feet of Van Dyke photostats, blue prints, and solar bromides, and 5,515 square feet of wet plates; mounted 314,500 square feet of maps and 3,365 photos; developed 6,459 films; made 88,320 photo view prints and 51,694 prints of aerial photographs of Alaska; and enlarged 3,762 photo views. This was an exceptionally large volume of photographic work.

RESEARCH

Last year's report pointed out the necessity for a well-rounded, co-ordinated research attack upon the many-sided, complex forest problem of the country. It was explained that the system of regional forest experiment stations being developed by the Forest Service, with fresh stimulus from the McSweeney-McNary forest research act, is providing a means of bringing together and correlating on a regional basis investigations in forest and range management, forest products, forest economics, and erosion. The year's experience strengthens the conviction that this regional and subjective correlation will afford the best line of attack by research on the forest problem as a whole.

The possibilities of coordinated research are illustrated by the logging and milling studies, of which details are given later. In those studies the divisions investigating forest products, economics, and silviculture made a correlated attack upon the same problem. In California, for example, a comprehensive logging and milling investigation, which started with the trees in the woods and took them through the mill to the finished product, brought out the economic results of varied silvicultural practices, as well as of the costs and returns from utilizing logs and trees of different sizes and qualities. The study included the economic influence of insects and disease and will include the relation of these agencies, as well as wild life, to the growth and reproduction of the subsequent stand. Similar studies in the South gave special attention to the influence of growth conditions upon density and the properties of the wood. In the investigation of naval stores the forest products and management divisions have been making a combined study of conservative methods of turpentineing. Coordination of range management and erosion studies has facilitated the development of principles and practices in the intermountain region and in the Southwest.

The regional stations are greatly facilitating the development and expansion of a sound program of forest economic research. Under the stations this work is being regionalized and coordinated with research in all other lines. Forest economics involves largely studies of the application of the results of other research, investigations of regional forest resources and economic relationships, and the formulation of principles for application over broad ranges of conditions. These principles form the basis for public and industrial policies affecting forests and forest land.

The nation-wide forest survey, an undertaking of first importance, is being organized and prosecuted intensively as part of the station programs on a much more constructive basis than would be practicable otherwise.

The stations supply the needed facilities for coordination of regional research in forest entomology, forest pathology, forest biology, and, in short, for the entire forest research of the Department of Agriculture. At many of the stations representatives of other bureaus work in close association with the Forest Service organization. During the year a forest biologist was assigned to the Appalachian station and one to the Lake States station.

Furthermore, the stations furnish the nucleus for a concerted attack upon regional forest problems by State and private organizations. In practically every region, and at the Forest Products Laboratory, close cooperation has been effected between the Forest Service on the one hand and the State foresters, forest schools, State agricultural colleges, and State experiment stations on the other. In California counties and municipalities also are actively participating in the conduct of forest research. Lumber and pulp manufacturing organizations and associations, other industries, livestock producers, water users, and scientific bodies are likewise cooperating.

During the year one new forest and range experiment station, the Intermountain, covering Utah, Nevada, and southern Idaho, was formally organized on a regional basis, with headquarters at Ogden. This station, which absorbs the Great Basin range station, and for which increased funds were provided by Congress, now brings together on an expanded basis studies of the range, erosion, and silviculture.

Stimulus was given to the establishment within the national forests of a comprehensive system of experimental forests and ranges, the purpose of which is to make permanently available for silvicultural, range, products, and other related forest research carefully selected representative areas large enough to meet expressed and foreseeable future needs. In essence these areas are field laboratories. In the interest of most effective accomplishment, the work of the forest and range experiment stations will be concentrated as fully as possible upon them. Most of these experimental forests will vary from 1,000 to 3,500 acres in area. Eight forests have now been established—the Priest River Forest in northern Idaho, the Fort Valley in northern Arizona, the Bent creek near Asheville, N. C., the Gale River and Bartlett Forests in the White Mountains of New Hampshire, the Fremont in Colorado, the Bernice in Montana, and the Upper Peninsula in Michigan; also two experimental ranges—the Santa Rita Range in Arizona and the Jornada in New Mexico. The expansion of this system is being aggressively pushed as a fundamental basis for the effectiveness of the regional work.

Emphasis is also being placed upon the establishment of natural areas. The purpose is to preserve permanently and in an unmodified condition areas representative of the virgin growth of each forest or range type within each forest region, to the end that the characteristic plant and animal life and soil conditions shall continue to be available for the purposes of science, research, and education.

Funds made available for research activities under various appropriation items for the fiscal year 1930 are compared with the amounts for 1929 and 1931 in Table 26.

TABLE 26.—*Appropriations for research for 1930 as compared with those for 1929 and 1931*

Class of research	Appropriations for fiscal year—		
	1929, directly appropriated ¹	1930, directly appropriated	1931, directly appropriated
Forest management investigations.....	\$377, 407	\$413, 000	\$488, 500
Forest-products investigations.....	542, 596	585, 000	635, 000
Range investigations.....	52, 680	67, 000	85, 000
Forest economic studies.....		25, 000	50, 000
Forest survey.....		40, 000	125, 000
Forest-taxation study.....	63, 640	65, 000	70, 000
Forest-insurance study.....		10, 000	10, 000
Erosion-streamflow studies.....		30, 000	30, 000

¹ Includes Welch Act increases.

FOREST ECONOMIC INVESTIGATIONS

The investigation of the financial aspects of private forestry practice, one of the major and fundamental economic projects authorized by the McSweeney Act, was organized and field work was begun. This is the first comprehensive appraisal ever undertaken on a nationwide scale of the costs of and revenues from private forestry. It is a constructive determination of the natural conditions, silvicultural methods, and other factors making it possible to grow timber at a profit. The southern pine region, because of its enormous productive capacity and broad economic importance, was selected as the first for intensive work. A thorough study of conditions on the ground was made for six counties, scattered through several States and carefully selected to typify representative conditions. These were intensively studied as to their forest resources, the existing practices of land management, utilization, and marketing, and as to forest growth conditions. A careful analysis is being made of the present and potential financial returns from the integrated use of forests for naval stores, lumber production, and for other purposes. Progress reports are in various stages of completion for these counties, which will make the information available to local forest-land owners and operators and will lay a foundation for the comprehensive conclusions of the study for the region. The county studies have clearly shown that under many conditions forestry will give a reasonable return on the money invested and that there is great opportunity for the adoption of improved methods and efficient integration of forest uses. Indications are that for many sections the maintenance of a reasonably prosperous local economy depends upon the wise use of a large portion of the land for forest purposes.

A forest-insurance study was organized as part of the program of the Pacific Northwest Forest Experiment Station, to appraise the possibilities and formulate principles of fire insurance as an aid to private forestry. The year was devoted to an exploratory study of the literature and experience at home and abroad, to establishing advisory and cooperative contacts, and to preparing plans for the more intensive work.

The results of a study of land utilization in central West Virginia, made in cooperation with the Bureau of Agricultural Economics,

were analyzed and prepared for publication. These show that large areas in the mountainous sections hitherto used for crops are clearly submarginal for such use and are well suited for growing timber. Forest lands under prevailing practices are producing only a small fraction of what they might under better methods. Farm woodlands can be made a much more important factor in the farm economy of the region than they are now, and together with other second-growth timber tracts can maintain local wood-using industries which, themselves, provide important markets for labor and farm products.

Cooperation was continued with the Bureau of the Census in the collection of the lumber-production statistics for 1929 in the 12 Western States, which include nearly half of the entire lumber cut of the country. The Forest Service also biennially makes a questionnaire canvass of lumber distribution. Through the cooperation of the Canadian Government statistics of lumber distribution between the individual States of the United States on the one hand and the individual Canadian Provinces on the other hand were made up for the first time. This gave a much more comprehensive picture than was ever available before of the quantities and sources of lumber consumed in the United States and Canada.

FOREST SURVEY

Initial plans were made and field work was begun on the nationwide forest survey. This survey, authorized by the McSweeney Act, is to be a comprehensive appraisal of the Nation's present and future requirements for forest products, the present and potential forest growth, existing volumes and qualities of timber, the areas and conditions of forest lands, and other facts needed as a basis for balancing the timber budget. It is one of the most important and far-reaching undertakings ever launched by the Forest Service. It is fundamental to forestry and of national significance.

The survey will be prosecuted, particularly the resource inventory and growth phases, by special staffs added to the regional stations. Work on a comprehensive basis will be restricted to a few regions at a time, and the detailed and essential facts as to the forest conditions for each region will be made available as rapidly as possible in advance of the completion of the survey for the country as a whole. These facts will constitute a reliable and greatly needed foundation for the development of local industrial and public programs.

The Douglas fir region was selected as the first for intensive field work. Plans were prepared, the technical staff was organized for work outside the national forests, cooperation was arranged with the administrative organization to cover the national forests themselves, and cooperative contacts and arrangements were made with many other agencies. Field work was commenced on a considerable scale on the physical-resource inventory—that phase which will be the most time-consuming and expensive.

Cooperative work was commenced in the Lake States, under the Lake States station, to supplement the three State land-economic inventory projects with such additional information on the forest resources as is needed to make these local undertakings of full value to the forest survey itself.

The data secured in the statistical canvass of the wood requirements of the secondary wood-using industries for 1928 were compiled

into three United States tables, showing the quantities used by the 60 classes of manufacture, by kinds of wood and by States, and the results were made currently available in progress-report form for State foresters and industrial and other agencies. Compilations are also completed and will appear in similar form, showing the situation in considerably more detail by States. This canvass and the compilations constitute only one step in the investigation of the Nation's needs for wood and for forests—one of the major phases of the forest survey, and one which bears directly upon land use.

Substantial progress was made in formulating the intricate and detailed plans for handling the resource-inventory phase of the survey, not only for the Douglas-fir region, but also with necessary correlation for all regions. Much work still remains to be done in the formulation of plans as the growth, drain, and requirements phases of the survey are taken up in more detail. Funds have been made available for the expansion of the work in the Douglas-fir region during the present year, for the initiation of intensive work in the southern Mississippi hardwoods, and for vegetative type-map work in California.

FOREST TAXATION

Effort was mainly devoted to the analysis of data already collected. At the same time field work was undertaken in North Carolina, and the collection of data for two of the three counties selected for special study was in large part completed. This will be one of the States to be intensively studied as a sample of regional conditions.

The office study of European tax conditions affecting forestry was advanced by material collected in France, Switzerland, and Germany by a well-qualified expert in European taxation and by a very careful office analysis of forest-tax legislation and conditions in Norway and Sweden.

A study of the effects of existing forest-tax legislation in the United States was initiated. This study had been left to the later stages of the general investigation so as to secure results based upon the longest possible experience with the more recent laws.

Four progress reports were issued, entitled "The Forest Counties of Minnesota: Tax Base (continued), Tax Rates, and Tax Burden on Wild Land," "Assessment Ratios of Rural Real Estate in Oregon and Washington," "Digest of State Forest Tax Laws Enacted or Revised During the Calendar Year 1929," and "Methods of Research in Forest Taxation." There was also made available in multigraph form a preliminary set of tables relating to forest taxation in New Hampshire. These reports serve to make the most important factual information currently available and useful, not only to the staff of the inquiry, but also to State and other agencies concerned in problems of taxation and public finance from the forestry and related viewpoints.

FOREST MANAGEMENT AND PROTECTION INVESTIGATIONS

Research in forest management seeks the facts that must be known in order fully to utilize the many and diverse forest types and soils of the country. The field is broad. It covers all that affects or determines forest growth from seed to harvest, and also the effects of the forest upon climate, stream flow, and erosion.

At the Pacific Northwest Forest Experiment Station a study was made of methods to obtain prompt and adequate new growth when the virgin stands are cut. The common logging practice in the region is to cut the forest practically clean and to burn the slash broadcast. Seed for restocking must come largely from adjacent timber and from such scattered and usually worthless individual trees as may be left. Adjacent timber, however, may soon disappear before the advancing lumbering operation, and the scattered individual trees may not long survive. It is important to know how far and in what quantity seed is distributed and what conditions favor or interfere with its germination and with seedling survival.

Seed dispersal was studied by liberating seed at different heights and wind velocities. While seed released in a low wind at a height of 200 feet fell in quantity up to 1,200 feet away, and in a very high wind some seed traveled as far as half a mile, under natural conditions in a light seed year no seed was obtained more than 500 feet from the seed trees. On soil blackened by a slash fire, surface soil temperatures were found to reach 144° F., sufficient to kill Douglas fir seedlings. This points to the need for giving careful attention to the number, distribution, and location of seed trees for the sake of shade as well as for effective seed distribution, and also raises questions regarding the use of fire on cut-over areas.

In regions where most of the virgin timber has been removed the principal center about which the individual studies group is the conversion of a greatly deteriorated forest into one of good possibilities. For example, in the Lake States very extensive stands of jack pine, aspen, birch, and scrub oak have succeeded most of the valuable virgin white and Norway pine. The jack pine and aspen can be used for pulp, but as yet the birch and stunted oaks have little value. It would take centuries for unaided nature to rehabilitate these areas with a valuable forest. The Lake States Forest Experiment Station is now giving particular attention to conversion measures. Preliminary results of such experiments in the scrub oak lands of northern Michigan and in the aspen-birch lands of Minnesota have been published. A somewhat similar problem in the northeastern spruce region concerns holding in check fast-growing but undesirable hardwoods which invade cut-over areas and prevent or retard the further development of young spruce already on the ground. By cutting back some of this inferior growth at the proper time during the first few years the spruce can be encouraged at a cost sufficiently low to make this practice feasible. The results of similar experiments in the southern Appalachian region show equal encouragement for the continued production of the valuable yellow poplar by removing the competing sumac and silverbell, neither of which has commercial value.

Successful reforestation calls for planting stock grown from sound, healthy seed produced by thrifty, straight-growing parent trees under climatic conditions similar to those of the site where the planting is to take place. Studies of Norway pine seed at the Lake States Forest Experiment Station emphasized the danger of frost damage or failure due to droughts before the planted tree reaches maturity if the seed came from an unlike climatic zone.

Studies at the Lake States station indicate that the slowness of germination of white pine seed in the nursery, which has stood in the way of effective practice, can be overcome by simulating natural conditions. Prompt germination was obtained by mixing the seed with moist sand or sawdust and storing in a cold cellar for from two to four weeks before spring sowing time. This gave all the advantages of fall sowing without the danger of rodent losses. That low temperatures tend to increase the percentage of germination of stored seed has been found to be true of species with such different characteristics as the northern white pine and the southern longleaf pine. Because of the rapid rate of deterioration it has rarely been possible to store longleaf seed more than one year. The Southern Forest Experiment Station has discovered that storage at low temperatures apparently not only lengthens the period of vitality but actually increases the germination percentage.

The establishment of what may be termed a seed-control station at the Lake States Forest Experiment Station, in cooperation with the College of Agriculture of the University of Minnesota, permitted the inauguration of a seed-testing service to the various forest agencies of the region, and insures uniform tests year after year of the seeds used in all research activities. Some 200 germination tests have been made since the equipment was installed.

Naval-stores research continues to strengthen the case for conservative methods of working pine timber. Proof that trees less than 9 inches in breast-high diameter are operated at a loss has led the factorage houses to stipulate in this year's contracts that no smaller trees shall be worked. The development of a new chipping tool opens the way for further improvement. With it a small, narrow face is made, similar to the French face, and yields are obtained which compare favorably with those obtained when the American hack is used. The new tool, in contrast to that used in France, can be used readily by the local woods labor, overcoming one big obstacle to the adoption of the French type of face.

Other results relate to the need for better judgment regarding what trees are to be worked and where the face is located. Operators suffer a considerable loss by facing low-yielding trees or by putting faces on the wrong side of trees. Great differences have been found to exist in the yield on different sides of the same tree. Trees with one-sided crowns produce more resin on the side with the largest branches, and faces placed above old fire scars produce little resin. Operators could make further savings by varying their working in accordance with seasonal conditions. In hot, dry summers trees chipped twice a week will supply good yields of a high grade of resin without injury, while during a rainy summer even one chipping a week may not pay. In the cold fall or early spring frequent chipping does not stimulate the resin flow, which continues for from 10 days to 2 weeks after chipping.

Forest-fire control continues to be one of the most difficult and pressing of all American forestry problems, and more research in every region is urgently needed. Further detailed analysis of the records of past fires by the regional forester of the California National Forest region and the director of the California Forest Experiment Station afforded the most outstanding contribution of the

year to the solution of the fire problem. This continued earlier studies by the same men on the very direct interrelationship between cover type, fire hazard, and fire control. A publication recording the results of these further studies was prepared, and has appeared since the close of the year. It was shown that fires must be caught within a time varying with the different types of forest cover, the degree of risk, the amount of fuel, and the accessibility in order to control them while they are still small. The desired "hour control," or degree of protection which it is feasible to undertake, is applied by devising a correlated detection and suppression system, including means of communication and travel, that will insure the presence of a force of fire fighters of specified size and equipment anywhere within a specified time after a fire starts. Increased funds made available for fire research in the coming year will be expended in carrying these California studies further. One of the aims will be, by applying intensively the results of previous research on a single forest, to discover what additional protection features are necessary to make a large unit practically safe from fire. There is great need for similar statistical studies of past fire records in other regions.

Since lightning is the principal cause of fires in the West, much attention has been directed to the lightning hazard, and hundreds of lookouts now record facts concerning lightning storms. In the northern Rocky Mountain region more than 15,000 reports have been made on these storms in the past five years. Many of these storms have never been recorded by the regular Weather Bureau stations in the agricultural valleys. Analysis of these lightning-storm records by the Northern Rocky Mountain Forest Experiment Station has permitted a more accurate classification of the lightning hazard on various forest areas. It has also shown that certain types of storms are more dangerous than others, and warnings can be given of their approach, enabling the fire-control forces to make preparations for meeting the special hazard.

Through analysis of the 5-year records of a forest-fire weather station in the spruce-hardwoods type in the Adirondacks the relationship between weather and forest fires was studied from the standpoint of the effect of each weather element upon the various fuels present in the forest. For the dense forest six degrees of hazard, from generally safe to extremely dangerous, were recognized. Separate hazard tables were prepared for cut-over lands, where the fuels respond more quickly to changes in weather conditions. Similar fire-weather stations have been maintained cooperatively in the Northeast in the spruce slope type of eastern New York, the white pine type of Massachusetts, and the spruce type of northern Maine.

To carry the study of forest inflammability one step further, an experimental fire forest has been established by the Lake States Forest Experiment Station in cooperation with the Michigan Department of Conservation, where will be determined the effect of such factors as temperature, humidity, and wind velocity upon the ease with which fires will start in different fuels, and upon their rate of spread. Tests of fire-fighting equipment and of fire-fighting methods will serve to demonstrate how best to control fire under varied weather and fuel conditions at different times of the year.

EROSION-STREAMFLOW INVESTIGATIONS

To determine the part that forests play in the control of erosion under varying local conditions, existing studies were amplified and new ones were initiated. Two are of particular note. In the regions where they are conducted erosion contributes heavy burdens of silt to the Mississippi River. One concerns the easily eroded fine silt loam uplands east of the lower Mississippi River.

The soil is sometimes 75 feet deep. A survey of several counties revealed that from 0.3 to 8.3 per cent of the cleared land was actively eroding. Land was found which in 20 years had made the complete cycle from forest through cultivation to abandonment. Forestry control measures are being developed to prevent further soil loss on areas permanently wrecked for agriculture.

Erosion is critical in southwestern Wisconsin also. Measurements of silt caught in silt traps indicated that forests are the form of vegetative cover most effective in holding the soil. Hay lands when in good condition hold soil nearly as well, but more rain runs off. Bluegrass pastures with unbroken sod hold the soil firmly, but when they are closely grazed gullies are apt to form. Closely grazed pastures are very ineffective in retaining water and deliver almost all of it to places where erosion may occur. Cultivated fields erode badly, especially where cultivation does not follow the contours. To control erosion contour-plowing, terracing, the construction of dams in gullies, and the diversion of water above the fields are suggested. Keeping land in forest immediately above cultivated fields is an effective farm-management measure.

Fifteen years' measurements and observations in Utah have shown how the restoration and proper grazing of high mountain range lands lessen surface run-off, soil erosion, and the intensity of summer floods. Increasing the herbaceous vegetation approximately two and one-half times had little if any effect on surface run-off from melting snow, but the burden of sediment in this run-off was reduced 57 per cent. Run-off from summer rains, which even under the depleted plant cover furnished only 5 per cent of the yearly surface run-off but carried 85 per cent of the eroded material, was cut more than half by the increase in vegetation, as was also the soil erosion due to them. A good herbaceous plant cover usually will not prevent flash summer floods from sudden heavy rainstorms in mountainous regions similar to those studied, but to a considerable degree will check torrential run-off and reduce floods. Because of the small portion that summer rainfall run-off makes up of the total annual surface run-off, any reduction in the summer surface run-off has no appreciable effect on the annual water supply. The maintenance of a good plant cover on the watersheds, by reducing the destructiveness of soil erosion and of summer flash floods, leaves the watercourses in a condition in which they can carry off the heavy spring flood from melting snow without destructiveness. A manuscript setting forth these findings was prepared for publication.

Preliminary studies were started on the Boise River watershed in southern Idaho during the year and produced the following interesting results: (1) There appears to be a definite relationship between quantity of precipitation and quantity of total stream flow over

periods of years, although individual years may show remarkable variation. (2) The average date when the stream flow of the Boise River has fallen below an amount required to prevent drawing on reservoir storage has been June 23 during the 10 years starting in 1920, as compared to June 29 during the 24 years 1895 to 1919. (3) Averaging the flow of the Boise River for 10-day intervals by 5-year periods shows prior to 1915 an average date of peak flow between June 1 and June 10, while since 1915 the average date has been between May 11 and May 20. (4) Recent serious erosion is associated with depletion of the natural plant cover by overgrazing, trampling by livestock, drought, rodents, and fire. The situation is of so critical a nature that it justifies far more intensive study than can be made with present funds.

General studies of the relation of semidesert brush and herbaceous plant cover to erosion on the Roosevelt Reservoir watershed in Arizona established the fact that, under the conditions there found, shrubs or trees must have sufficient density for the ground surface to be controlled by litter, or must be supplemented by herbs, in order to prevent erosion effectively. Otherwise soil depletion is a constant process, at first between shrubs and trees and later under their crown spread. Areas within the semidesert brush zones where grasses have not been depleted do not show evidence of abnormal erosion. An area of approximately 60 acres, with rather steep slopes, that has been protected in part for 20 years, has revegetated to grasses and other herbs until they now occupy 35 per cent of the ground surface, and the sediment carried by run-off is so slight it could not be measured. The common practice in the region, however, has been to graze much of the range yearlong with such numbers of livestock that the grass growth is completely utilized long before a new supply becomes available. The stock then have to be maintained on brush until new grass growth appears. Consequently, following each year or cycle which does not receive rainfall in quantity or character favorable to the growth of grass, the grass density very rapidly declines. In the absence of grass the fine surface soil that was built up by and supported grass washes away readily. One 60-acre area with a 7° slope had over 2,000 cubic feet of soil eroded from it in less than two years. Another area with a steep slope lost an average of one-half inch of soil in less than a year. A vast amount of material has accumulated recently in small and large drainage lines, ready for transportation to the main river or the reservoir during the next period of excessive precipitation. The last 10 years have been deficient in precipitation. The very marked shortage of water supply and the extreme erosion occurring over a large part of the watershed demand an intensive study to determine what plant cover encourages the maximum of storage water with the least silting of reservoirs and how this cover may be restored and maintained under the periodic droughts which prevail in the region.

FOREST-PRODUCTS INVESTIGATIONS

Wood is both a raw material and a storehouse of raw materials. It contains cellulose, lignin, pentosans, and extractives, combined in variable quantities and arranged in a complicated and variable microscopic structure. The chemical composition of wood substance,

the arrangement of constituent parts in the wood cell, the size and spacing of the cells, and the variation of all such characteristics according to species and growth conditions determine the usefulness of wood, whether as wood or as something else. A scientific understanding of these matters opens the way to success in the silvicultural control of the material and its properties, in its selection, its seasoning and handling, its impregnation with preservatives, its use in construction, its conversion into pulp and other products—in short, affords the only means by which our national economic requirements and our forest land can be brought into the most serviceable adjustments with each other.

GROWTH, COMPOSITION, AND CHARACTERISTICS OF WOOD

Research is making clear the principles whereby the forester can predict and control wood quality by the conditions under which the tree is grown. For example, tests conducted for the last three years by the Forest Products Laboratory in cooperation with the Southern Forest Experiment Station have shown that for southern pine a moist site, protection from fire, and relatively close stands of trees produce dense, strong wood. Soil fertilization is less important than water supply. For a rapid production of lightweight wood of moderate strength the main requirements are fire protection and open spacing in the stand. Specimens of second-growth Douglas fir were found to be of lower density and less strength, on the average, than virgin-growth material—an illustration of the frequent effect of wild-land conditions on second growth and of the need for careful silviculture if the most satisfactory timber crop is to be obtained. In contrast to the conifers, hardwoods produce their strongest material when sustained or increasingly rapid growth occurs in open stands or as the result of thinnings. These and related data on the control of wood quality, accumulated over a period of years, were published during the year in a technical bulletin.

Factors of growth can now be taken into account in setting a commercial value for pulping purposes on stands of spruce, hemlock, aspen, birch, jack pine, southern pines, and about 15 other well-known or potentially useful pulp-wood species. Of special interest from the silvicultural point of view was the evaluation of a 37-year-old planted stand of Norway spruce in Wisconsin, in which dominant and suppressed trees were found equally good for conversion into sulphite pulp. The value set on this wood was \$11 per cord, or \$577.50 per acre, delivered at the mill. The new method of evaluation, developed this year and correlated with the results of pulping trials, is largely a process of sampling and chemical and physical testing. It is rapid and simple as compared to pulping trials and should aid both the marketing and the growing of pulp wood.

Additional data were obtained on the relations between wood structure, growth conditions, and such variables as longitudinal shrinkage, brashness, plasticity, and the formation of compression wood. The general objective of these studies is the detection of abnormal or inferior material and its causes, and their abatement through silvicultural control. A limited number of measurements showed that the

longitudinal shrinkage of redwood varied inversely with the density, not directly as is the rule for transverse shrinkage. Excessive longitudinal shrinkage was found to be a characteristic of very rapidly grown loblolly pine and redwood, entailing a serious handicap in use. Compression wood, recognized as a source of abnormal lengthwise shrinkage in softwood lumber, was found to be somewhat stronger than normal wood when green, but the advantage disappeared upon air-drying. A tendency was noted for compression wood to increase in amount with the lean of a tree from the vertical and with accelerated growth rate. The species included in the year's study were western and southern yellow pines, Douglas fir, redwood, and white fir. Mill studies of white fir revealed compression wood in about 8 per cent of the pieces of lumber examined, only a small part of which was of the pronounced type, a fact confirming the belief that this defect is a no greater problem in white fir than in other important species.

New applications of scientific method during the year gave a closer view of wood structure and substance than has ever before been obtained. Units that may be the smallest physical aggregates of the wood cell were observed under the microscope. These are minute subdivisions of the "fusiform bodies," which make up the fibrils, which in turn unite to form the cell walls of wood fiber. Beyond the power of the microscope the X ray was used to examine the physical orientation of molecules in the wood structure. Preliminary experiments, conducted in cooperation with the University of Illinois, indicated that wood cellulose consists of molecular chains regularly arranged in a pattern which is modified according to the species and condition of the material. Compression wood gave a distinctive picture which may be an effect of the slope of fibrils previously noted in the cell walls. On further development the X-ray method should afford a powerful means of determining and explaining differences between wood species, as well as between light and dense and wet and dry material.

From new electrical conduction tests it was concluded that the open area effective for the passage of liquids through and between the cells of Sitka spruce heartwood is approximately one-thousandth of the total cross section of the piece. Other woods will be similarly tested and the results checked by drying constants in the effort to arrive at a clearer view of wood structure and its mechanism in seasoning and impregnation processes.

CHEMISTRY OF WOOD

New values for forest thinnings, unused species, and logging wastes will accrue when industry is able to take miscellaneous woods material and transform it into useful products in greater variety and on a larger scale than has yet been attained. The possibilities in this direction are indicated by the already huge output of such technical products of wood as pulp, paper, rayon, viscose, and lacquers; but the development of new and improved products and their commercialization is ultimately dependent not on chance discoveries but on the results of scientific research, seeking always a clearer knowledge of the material and its chemical relationships. This principal holds

good throughout modern industry; it applies to wood no less than to metals, oils, foodstuffs, dyes, rubber, and textiles.

Significant progress was made in this year's study of wood cellulose. Research conducted by a member of the laboratory on furlough at the University of Upsala, Sweden, resulted in the first recorded determination of molecular particle sizes of pure cotton and wood celluloses in solution. A new scientific instrument, the ultracentrifuge, was used. Particles of the same size as those in cotton were found in wood cellulose, together with other particles in a definite series of fractional sizes. This is an approach to solution of the problem of the molecular weight of cellulose, definite knowledge of which is fundamental to an understanding of the chemical properties and transformations of the material.

By disintegration of wood with chlorine under the direct rays of sunlight instead of diffused light the soluble part of the cellulose was largely increased and the solid residue diminished. The scientific value of this result lies in the new soluble fractions made available for analysis and study. From the immediately practical point of view, it may point the way to larger yields of pulp from wood by excluding light from vessels in the beating and bleaching operations.

Lignin, a material making up one-third the weight of wood, is at present a mere industrial waste, of practically unknown composition, with few if any uses and an urgent disposal problem. Yet if its chemistry were better understood, it might prove as rich a source of useful products as the once disregarded coal tars. It was discovered that after all possible carbohydrates or sugarlike bodies had been removed from lignin, more of them could still be produced on suitable chemical treatment. If, as seems likely, these carbohydrates were not present in the original wood but were made by chemical action on the lignin itself, an important clue to the composition and properties of the material has been developed. This clue will be followed up in the intensive study of lignin planned for the coming year.

The chemical study of wood extractives was supplemented by an investigation of their influence on the mechanical properties of black locust, western red cedar, and redwood. In each species the heartwood, containing the extractives, was found higher than the sapwood in certain strength properties, the difference in crushing strength, particularly, being considerably greater than differences in weight would indicate. In shock resistance, however, there was some indication of an opposite effect.

Forest Service research in the field of naval-stores production has pointed out important improvements. Preliminary studies of the physiological differences between individual trees as resin yielders were conducted, and preparations for their enlargement are under way. Meanwhile, the facts already known are finding wider practical application. Florida naval-stores factors, in direct touch with practically all turpentine producers in that State and cooperating with leading Georgia factors, this year canceled all old lease forms and issued a new one stipulating that no tree under 9 inches in diameter shall be cupped. Numerous progressive operators took steps to reduce the height of chipping in their workings conformably with Forest Service recommendations. Similar results are following throughout the producing region.

WOODS AND MILL INVESTIGATIONS

Continuation of logging studies in one region after another has resulted in marked interest on the part of lumbermen as to the effect of selective cutting on production costs and returns and on the possibilities of a short cutting cycle. Definite knowledge of the qualities and sizes of logs that yield a profit is in many cases opening the way to improved woods practice and sustained yield operations by forest owners. Preliminary analysis of the work done during the year in the second-growth shortleaf and loblolly type of the southern pine forest region indicated that the manufacture of lumber from trees 10 inches in diameter netted a loss of \$3.29 per thousand board feet, not including stumpage, as against a profit of \$11.73 from 24-inch trees. Figures are being worked out for the three other southern pine types and the other methods of operation studied during the year. A technical bulletin on the selective logging of hardwoods in the Lake States, based on previous studies, was published and widely distributed.

Selective cutting provides a means of natural restocking of the land, makes possible a short cutting cycle, allows selection of the material and of the place of cutting, and maintains or increases the profits to the owner as compared to other forms of forest management.

The field work on a very comprehensive woods and mill study in California was completed. It involved following from the woods through the mill about 1,000 trees, cut into about 5,000 logs, to ascertain the amount of lumber by grades that each tree yielded. A study made in Oregon showed that to produce western yellow-pine lumber from 10-inch trees cost about \$10 per thousand feet more than the value of the lumber, whereas with 30-inch trees the cost was about \$10 less than the value. The results of this study were published serially in a lumber trade journal. Marked progress was made in studies that have been under way in the Inland Empire for several years to determine the amount of waste in logging due to breakage in felling and in gravity chuting. These woods and mill studies are of direct aid in national-forest management as well as in the development of commercial forestry.

Special attention is being given the small mill in order to find means of compensating for or correcting its bad points and so utilizing its good points that it may sooner find its permanent place in sustained forest practice. Investigation thus far shows that the small mill operator, in figuring his production costs, ordinarily ignores items amounting to some \$2.50 per thousand board feet, or from 9 to 22 per cent of the total cost, and that by greater care in the adjustment of set works on the carriage the yield of salable lumber can be increased by as much as \$1.60 per thousand.

The development of log grades, practical seasoning and stain-prevention methods, and simple rules for lumber grading adapted to the requirements of the small operator are other items receiving attention. The plan of work that has been put into effect during the year calls for close cooperation between the Forest Products Laboratory and field agencies of Federal, State, and commercial forestry interests, and the response thus far is most encouraging.

Analysis of the data obtained last year in studies of dimension-stock production from woods and mill waste in the Lake States

showed that with fair-quality logs between 8 and 11 inches in diameter there was a margin of \$13 per thousand board feet between cost of production and selling price at the mills studied. Costs decreased and values increased with increase in the size of logs. The cutting of dimension stock instead of lumber may be one solution of the problem of small and defective logs.

Arrangements are well under way for work in the Northeast on methods of dimension-stock production adapted to small operations or groups of operations as a solution of the marketing problem of small mills. The investigation is expected also to produce methods adapted to the handling of pulpwood species and thinnings.

A great and significant increase has taken place in the last 10 years in the use by the wood-consuming industries of cut-to-size stock instead of standard lumber. This change in industrial point of view, which in a considerable degree has been based on the work of the laboratory, should be applied increasingly to woods and forestry practice through continued research and demonstration.

SELECTION AND PREPARATION OF WOOD FOR USE REQUIREMENTS

The effective and discriminating adaptation of wood to the requirements of specific uses will more and more determine its ability to hold markets under modern conditions of competition; hence there is need for increased knowledge about and care in the selection, seasoning, grading, and handling of the material. This does not mean the narrowing of the utilization field to a few superior species but the intelligent preparation of many species to meet varied demands.

New knowledge of the properties of different kinds and grades of lumber was afforded by the analysis of data on the characteristic defects of 13 leading commercial softwoods. The results, to be published as a technical bulletin, have already proved of distinct value in the study of species for various uses and in dealing with important inquiries, and will assist lumber consumers in selecting material and lumber producers in improving and standardizing grades.

In Michigan, Wisconsin, and Minnesota alone some 29,000,000 acres of logged-off lands have grown up to aspen, a so-called weed species. The laboratory, in cooperation with other Forest Service units, prepared a publication on the properties and uses of aspen, showing its availability for pulpwood, boxing and crating stock, and a wide variety of small manufactures for which its properties are comparable to those of basswood and yellow poplar.

A similar study of western larch, now largely unused or sold in mixture with other species, showed that the species is in reality one of our best general-utility woods and should be readily marketable under its own name if given proper seasoning and attention.

Continuation of dry-kiln studies showed that casehardening of lumber can be reduced still further by modifications of the drying conditions to suit two main types of wood, the sapwood type and the heartwood or refractory type. In the latter type, such as white oak, red gum, and the heartwood of most species, the degree of casehardening was found to be determined by the slope of the moisture gradient between the drying surface and the boundary of the saturated interior of the piece, and compensating humidity, tempera-

ture, and circulation controls were worked out for the improvement of drying schedules.

Previous studies of the seasoning of many species of lumber in the various producing regions of the country have shown that wide variations in the moisture content of the seasoned stock above and below the average are a prevalent feature of both air-drying and kiln-drying practice. Efforts are being made to determine and correct the causes of this variation. In an extended investigation of the kiln drying of Douglas fir nonuniform drying was found to be due principally to inadequate kiln design and not to inherent characteristics of the species. In keeping with the findings of this study, kiln manufacturers have revised their design factors to provide increased circulation efficiency. Drying investigations of other western woods are under way.

Little difference between mild and rather severe seasoning schedules was observed in a study of the drying of small-dimension stock from woods waste of maple and birch in sizes up to 1 by 6 inches and 1½ by 4 by 48 inches. In all cases the chief source of degrade was warping. Since end coating reduced checking to a minimum under the severest kiln conditions used, it is clear that for this class of stock accurate control of temperature and humidity is not particularly important. The amount of warp, measured in depth of bow per foot, was found to decrease considerably as the length and width of the piece increased. The production problem thus centers around sawing methods rather than seasoning. Satisfactory small-dimension stock could be made by cutting up the larger pieces after seasoning.

A bulletin on the kiln-drying of southern pine, intended particularly to reduce the quantity of degrade lumber in select and No. 1 common grades, was published and distributed in the industry. A bulletin on effective commercial air-seasoning methods for lumber was also issued and distributed to lumber manufacturers, dealers, and fabricators.

Theoretical and experimental studies of the kiln-drying of wood led to the completion of a master chart by the use of which drying rates, under any reasonable combination of kiln temperature and relative humidity, can be predicted from characteristics of the wood. These characteristics can be determined by a relatively small number of experimental kiln runs with each species. Since the new method successfully differentiates between the effects of temperature and humidity on drying rates, it constitutes a long step forward in the science of wood seasoning. Briefly, the tests required to establish complete drying curves by this method are numbered in tens instead of the thousands formerly needed.

The shrinking, swelling, and opening of joints of wood in service is due in part to drying the lumber to a moisture content too high or too low for the humidity conditions of the locality in which it is to be used. Complete data on the varying moisture content of wood in dwellings in five typical climatic regions of the United States showed yearly ranges varying from only 0.7 per cent in Portland, Oreg., to 3.8 per cent in Madison, Wis., with the actual moisture content varying from a low of 5.1 per cent in Albuquerque, N. Mex., to a high of 12.8 per cent in New Orleans, La. In northern locations a drop of as much as 2 per cent in the moisture content of woodwork was shown to occur in the fall months when the house-heating plant

was coming into steady use, with a correspondingly sharp increase in the spring. The data are now under analysis to show the influence of types of construction, heating plants, and other factors on the conditions of exterior and interior woodwork, and the results will be published for the information of owners, contractors, millwork manufacturers, and furniture makers who are concerned with the proper seasoning, handling, and use of wood in relation to climatic conditions. A leaflet was published during the year, pointing out the necessity and the means of keeping new flooring and woodwork dry at all stages of house construction, to prevent cracking and opening of joints after the house is occupied.

A needed investigation of the storage and handling of lumber in the yards and on the construction site was initiated, with the cooperation of interests concerned, and preliminary surveys of yards in the West, Middle West, South, and East were made. Bad practice, as a rule, appeared to predominate over good. Leaky roofs of storage sheds, green stock piled at mills and in dealers' yards with insufficient provisions for proper air circulation, low, damp, and rotten foundations, and poor segregation of green and dry material both in shipment and in storage were common. Such conditions, if generally permitted, are bound to nullify much of the gain that has been made in seasoning methods and to react widely against wood as a building material. A comparison of types of open and closed lumber sheds was begun at four yards in Chicago and at two southern pine mills. Assistance in a campaign to improve the storage and handling situation throughout the country is hoped for through closer laboratory contacts with engineers and architects.

An electrically operated instrument for the instantaneous measurement of the moisture content of lumber, embodying operating improvements over available commercial models, was perfected last year. Characteristics of the new instrument, described as a blinker machine, are simplicity, economy of construction and operation, portability, and accuracy to a moisture content of about 1 per cent. Its useful range is from 7 to 24 per cent moisture content.

INTERNAL AND SURFACE TREATMENT OF WOOD

One of the most productive fields in which forest products research has engaged is the modifying of wood properties by various types of treatment to enhance the values of the material, lengthen its life in service, and enable it to hold its place in use against new and competitive materials.

An important aspect of this work is the treatment of ties and timber with creosote and other preservatives. Laboratory studies on the impregnation of Engelmann spruce, followed by field demonstrations at railroad and commercial tie-treating plants, showed that it is possible to secure satisfactory absorption and penetration. Previously Engelmann spruce had been regarded as extremely resistant to treatment, and railroads of the Rocky Mountain region were at the point of refusing to accept any more ties of this wood, which is one of the most plentiful in the national forests in Colorado, Wyoming, and Utah. Such refusal would have been very serious from the standpoint of proper management of these forests.

Studies of the fireproofing of wood were continued. It is possible, although costly, to treat wood so that it will not burn by itself. Less expensive treatments must be found before wood treated to make it fire resistant is within the reach of the average consumer. The firetube method of testing developed at the Forest Products Laboratory is being used in an extensive survey of chemicals to determine which give promise of commercial usefulness as fire retardants. Results of intensive studies of zinc chloride and diammonium phosphates were published.

Progress made last year in securing information about the durability of glued joints under extremely severe moisture conditions promises to react beneficially on the manufacture of aircraft, automobile bodies, and many other specialties. Water-resistant casein-glued joints, impregnated with creosote or beta-naphthol after gluing, showed practically full strength after two and one-half years of continuous exposure to nearly saturated atmosphere, whereas untreated joints failed completely in about half the time. One series of treated blood-albumin plywood specimens, exposed for four and one-half years in a moisture-saturated atmosphere, showed no appreciable loss in strength. Adding the preservatives directly to the glues also increased their durability, but the untreated wood decayed and failure occurred sooner than when the whole joint was treated.

A bulletin describing and explaining the special phases of wood gluing in aircraft manufacture was prepared.

The study of painting characteristics of softwoods, carried on for five years, has made it possible to classify the principal American softwoods in four groups with respect to painting quality. The lighter, even-textured woods hold paint coatings longer than those of greater density and uneven texture, and spring wood gives better anchorage for paint than summer wood. A leaflet presenting these and other findings of the investigation in simple and summarized form was published in 1930 and the preparation of a technical bulletin was begun. An advisory committee of prominent representatives of the industries was organized to consult with and assist the laboratory in its further painting research. The work to date has made clear that variation between woods in painting characteristics and the most troublesome defects of paint coatings are due to inadequate adhesion between aged coatings and wood. Research should be directed toward the problem of paint adhesion as soon as possible.

The results of many years' experiments with coatings to retard moisture changes in wood were prepared for publication as a technical bulletin. Aluminum leaf is the most nearly impervious of all the coatings tried, with aluminum powder varnishes, certain bituminous preparations, and spar varnish in multiple coats following in order. Many coatings popularly supposed to "seal up" wood against moisture are shown to be very low in effectiveness. Moisture changes and the dimension changes which accompany them cause most of the common difficulties encountered in the use of wood. The field of investigation in moisture-retardant coatings is very large, and new products are constantly being offered. Testing and original research are being continued.

MECHANICAL ADAPTATION OF WOOD TO CONSTRUCTION AND FABRICATION

Over 60 per cent of the lumber produced in the United States is used in building construction, about one-half going to the farm and one-half into urban residences and industrial buildings. In this highly competitive field lumber is losing ground to other materials, not primarily because of its unfitness but because of inefficient design and use, as evidenced by twisted buildings, bulged sides, sagged roofs, buckled rafters, broken ties and beams, misfit doors, hay carriers out of commission, and farm and other buildings demolished by storms or torn down because unserviceable. Tests of timber, structural combinations, and fabricated parts are conducted by the laboratory to promote the use of wood in strong, efficient, and satisfactory construction.

Rules for the design of bolted and fishplated timber joints were worked out last year through tests on joints of Douglas fir, southern pine, spruce, oak, and maple fastened with common steel bolts of diameters up to 1 inch. Steel fishplates, replacing wood cleats, were found to increase the efficiency of joints 25 per cent. As a result of the tests the allowable stress in joints at any angle with the grain of the wood can be calculated from the diameter, length, and number of bolts. Since disastrous failures of wood construction often occur as a result of faulty jointing, the engineering value of this study is obvious. The results, to be published in bulletin form, will replace much rule-of-thumb with new technical facts.

The details studied are essential to proper construction in building as well as other lumber uses, but they are only a beginning. The design of most frame buildings is such that the stresses in the members are indeterminate, and it is only through tests of the wall panel, the entire floor panel, the braced rafter, the roof truss, and ultimately the entire building, that proper design will be obtained.

Five studies of the use of wood in aircraft were published or made ready for publication as technical reports of the National Advisory Committee for Aeronautics. These concern the torsional resistance of wing-beam sections, the design of plywood webs for beams, the design of wing ribs, a method of calculating the ultimate strength of continuous beams, and the properties and selection of aircraft woods. Their publication places at the disposal of civilian aircraft engineers and builders the results of years of research carried through as a special cooperative project for the Army and Navy Air Services. Furthermore, they illustrate the successful adaptation of wood to one of its most exacting uses, a fact which promises well for the future of wood in the general engineering field.

Tests to determine the effect of moisture distribution on the strength of poles and structural timbers were completed. The results show that the effects of moisture in large members under outdoor service conditions are difficult to predict theoretically, and that strength values for members of a given species should be judged by tests of like members similarly exposed, rather than evaluated by rule. Recommendations to this effect, with a record of the tests on which they are based, were published in association proceedings.

Shipping crates for bulky commodities are often so insecurely braced that heavy stresses in transit fall upon the commodity itself, with resultant damage. A recent laboratory analysis of stresses

occurring in crates led to published recommendations that show how to prevent such damages through more effective yet economical use of wood bracing. Facts obtained by the laboratory in its preliminary survey of damage to canned foods in transit were embodied this year in a leaflet issued to freight claim representatives by the American Railway Association, calling for improved stowage and better preparation of cars to receive freight. A comprehensive manual of box and crate construction forming a general summary of the laboratory's container investigations up to the present was issued. It met with a demand from shippers and railway men that quickly exhausted the first printing. Other laboratory publications on the mechanics of wood and wood construction during the year included a departmental bulletin on the strength of timber columns that presented a new formula for column design, and also a bulletin giving simplified comparative figures for the strength of American woods.

WIDENING WOOD-PULP RESOURCES

If research can succeed in bringing about the practical commercial utilization of logging and milling wastes, of little-used species, and of varied types of second-growth timber in the economic production of pulp and paper of the right characteristics, not only will ample wood be available to meet our entire pulp and paper requirements, but some of the most troublesome problems of American forestry and land use will be solved. These considerations clearly define the objectives of pulp and paper research at the Forest Products Laboratory.

Favorable results previously reported in the production of strong white papers from southern loblolly pine were practically duplicated this year with longleaf by use of the laboratory's modified sulphate process. Slash and shortleaf will follow next in the southern pine pulping program, and meanwhile close study is being given to the development of products that can be manufactured cheaply and sold in large volume. Satisfactory book, writing, and grease-proof papers were produced from longleaf, and a highly transparent glassine largely of longleaf was made. The importance of the southern pines as a pulp-wood resource is measured by the great geographical range of these woods, their rapid growth rate, and their nearness to markets.

Black gum, a southern hardwood species in large supply, yielded an easy-bleaching pulp suitable for book, magazine, and writing papers, when pulped experimentally by the sulphite process. In the evaluation studies mentioned earlier a representative selection of American species was investigated for pulping quality. A thorough study of the pulping of southern cypress from the Everglades produced book and wrapping papers of fair quality, but in nowise superior to those made from the pines and other readily available woods. However, an eminently satisfactory insulating board was produced. This offers the best commercial possibilities for the material, since the fibers apparently retain characteristics of the original wood which give it distinctive values in construction.

The utilization of flax straw and hemp in pulp and paper products hinges on an efficient process for separating the strong bast fiber from the woody shive. If this is accomplished, the two components may then be processed by the methods best suited to preserve or develop their most valuable properties. The application of certain separation

principles, well known in the mining industry but heretofore not used for separating fibers, has given promising results, but its efficiency as a means of preparing paper-making fiber must still be demonstrated.

Seed-flax straw contains from 3 to 3½ per cent of waxy material readily extracted with organic solvents. One constituent of this material, amounting to approximately one-third of the extractive, has been identified as a sterol. In this class of compounds one—namely, ergosterol—is at the present time industrially important. Ergosterol when treated with ultra-violet light becomes antirachitic and is used in the treatment of rickets and similar disorders. The flax-wax sterol constituent has been subjected to ultra-violet light and been found to acquire distinct antirachitic properties. The matter is being given further study.

IMPROVEMENT OF PULPING PROCESSES

“Black liquor” (used cooking chemical) in the proportion of 40 per cent of total cooking solution was successfully reused in the pulping of pine by the modified sulphate process. This is a development of considerable promise in simplifying the problem of recovery of chemicals. Efforts are being made to extend the advantage of sulphite pulping—high yield, strength, and easy bleaching—to woods of high resin content. Very favorable technical results were obtained with jack pine and other resinous species by substituting soda for the usual lime base. Soda is more expensive, but if the improved quality of pulp warrants the operation of a soda recovery cycle a great source of stream pollution would be eliminated. The problem of soda recovery is now being studied with this major objective in view.

Methods for closer control of laboratory processes, means of evaluating products, and refinements of operation were sought in order to attain more effective and adaptable research results. A method of evaluating pulps by screen analysis, rate of flow, and static bending tests to determine their paper-making characteristics was developed. A new pore-volume apparatus was devised which more accurately determines the actual volume of solids and voids in a sample than any instrument used heretofore. This facilitated the closer evaluation of finished papers and the characterization of different types of paper. A study of the mechanical variables of the paper-making process was begun, in which the “draw” or tension on the sheet between successive machine sections is the first factor to be studied.

RANGE INVESTIGATIONS

Research to develop a scientific basis for range management began in 1910, when general studies throughout the national forests sought early answers to the first problems of grazing administration. During recent years more intensive work has been carried on, largely concentrated in central Utah and on two range reserves in the Southwest. Range lands furnish about 70 per cent of the feed for all livestock in the 11 far Western States, and constitute the major part of the watersheds from which the 19,000,000 acres of irrigated land in these States derive their water. Except on the national forests, where the productivity of the ranges has been improving, deterioration has reduced the vegetative cover on most of the western range, a large part of which is federally owned, by from one-half to

two-thirds in quantity and by even more in economic value. This has not only seriously affected livestock production but also greatly increased soil erosion and intensified flood damage. The object of range research is to develop sound practices of range management and range livestock management, and of regulated range use that will adequately protect timber resources, and in connection with erosion-streamflow investigations to protect water resources, without unnecessary curtailment of grazing.

In brief, the more important results obtained to date are:

The development of systems of range use which maintain the forage resource and increase carrying capacity by applying as basic principles deferred grazing and rotation grazing.

The accumulation of a large body of knowledge regarding the practical possibilities of artificially seeding range lands.

Establishment of the underlying principles that determine when certain specific types of mountain range may be grazed without injury to the vegetation.

The development of improved methods of managing livestock on the range. For sheep and goats the principal improvements have been through open herding, bedding out, and better lambing and kidding practices, leading to greater production, better growth, and higher market values. For cattle the improved methods have concerned mainly more efficient salting practices and the development of water, resulting in better distribution of the stock on the range, with fuller utilization of the forage crop and the prevention of overgrazing of limited areas through unnecessary concentration.

To these may be added the development of practical methods of eradicating tall larkspur, waterhemlock, death camas, and various other poisonous plants.

The McSweeney-McNary Act afforded a basis for planning a broader range-research program, organized along regional lines in place of local studies. In the Intermountain Region an appropriation permitting the establishment of the Intermountain Forest and Range Experiment Station makes possible an attack on the spring-fall and winter-desert range problems, two of the most critical confronting the range livestock industry. The cooperative studies of range-sheep management at the sheep experiment station maintained by the Bureau of Animal Industry in Idaho were materially expanded. They have shown the inadvisability of heavy early spring grazing and the gain in forage and lamb production obtainable through conservative grazing in spring and fall. Plans for similar range-management studies at the range livestock experiment station near Miles City, Mont., are being formulated. For the Southwest funds were provided to study the water requirements of range cattle in the western yellow pine forest type and the forms of livestock management necessary to prevent damage to forest reproduction and at the same time permit the maintenance of a profitable cattle industry. In this type cattle frequently damage timber reproduction even when considerable forage is on the range. Much of this damage appears to be due to lack of water at watering places or in succulent forage. Similar intensive studies will have to be made on sheep ranges.

An analysis of the results of the investigations that have been under way for 15 years at the Jornada Experimental Range in southern New Mexico made clearer the importance of conservative grazing at all

times, and of the use of certain specific measures to assure sustained livestock production during extended drought periods. Black grama, the most important range-forage plant on the reserve, suffers severely from too close and too frequent summer utilization and should therefore, if possible, be reserved largely for winter grazing. On the other hand, close and frequent clipping of tobosa grass, which occurs on flooded areas, stimulates its spread by rootstocks and increases forage production, making its full use during summer desirable. A preliminary report of the natural successional development of the plant cover on the sand-hill type was published. A similar report on plant succession on clay soil types of the Jornada is in course of preparation. These studies, as well as those on the better grass types, have demonstrated the necessity of intensive study of the restoration of the badly depleted sand dune and gravelly ridge areas of the Southwest. Such excessively denuded areas are not producing one-tenth of the forage that they might, and this depleted condition now seriously interferes with satisfactory utilization of the better range areas.

Marked progress was made in the analysis of information on the grazing values and growth requirements of western range plants. These studies are defining the plants which are of special significance in scientific range management and research and are determining their general relationships. Several papers were issued dealing with range plants, and a glossary of botanical terms was prepared to aid administrative officers. Knowledge of the western range flora was considerably increased by this year's collections of over 5,000 specimens, particularly with regard to economic values, range extensions, and species new to science or that were little known. Standardization of the nomenclature of western range plants, both English and Latin, was given special attention in cooperation with the Bureau of Plant Industry.

An irreparable loss was suffered in the death, in line of duty, in a forest fire on the Chelan National Forest in August, 1929, of Douglas C. Ingram, a highly capable forest officer, an authority on range management, and an outstanding student, collector, and photographer of the western range flora. In his honor a very handsome native, wild pink, discovered by him, has been named *Silene ingrami*. Effort is being made to grow the species from seed at the Arlington Experiment Farm, Rosslyn, Va., with the hope that eventually it may be introduced into cultivation.

Cooperation between the Forest Service and the extension services of the Department of Agriculture and the various Western States brought about considerable progress in the further development of the extension program of range management. Field days for the demonstration of the practical results of range investigations were held at the Great Basin station and the Jornada and Santa Rita experimental ranges. Stockmen are keenly alive to the value of the results and are pressing the service for further development of research in other parts of the West. Its expansion in the Southwest and inauguration in California are doubtless of most importance, where the interrelationship of grazing to timber production and watershed protection especially demands the study of ways to restore depleted ranges and assure sustained profitable production of livestock without injury to other resources.

EXPENDITURES AND RECEIPTS

The expenditures for all purposes during the fiscal year were as follows:

General administration.....		\$392, 640. 24
Forestry extension.....		180, 521. 59
Research:		
Silvical investigations.....	\$580, 884. 80	
Forest products investigations.....	640, 299. 19	
Range investigations.....	106, 957. 65	
Taxation study.....	61, 002. 03	
Total.....		1, 389, 143. 67
Administration, protection, improvement, reforestation, and extension of the national forests:		
Administration—		
Timber use.....	\$1, 233, 649. 44	
Grazing use.....	959, 196. 21	
Fish and game protection.....	132, 444. 63	
Recreation and land use.....	218, 362. 70	
Examination and administration of power sites for Federal Power Commission.....	23, 281. 00	
Classification, settlement, and claims.....	61, 235. 87	
General surveys and maps.....	146, 472. 12	
Grazing reconnaissance.....	107, 653. 99	
Timber surveys.....	239, 484. 69	
Subtotal.....		3, 121, 780. 65
Protection—		
Fire prevention and detection.....	2, 166, 422. 36	
Fire suppression.....	3, 754, 469. 08	
Protection against insects and tree diseases.....	320, 568. 28	
Subtotal.....		6, 241, 459. 72
Improvement—		
Construction of improvements other than roads, trails, and camp-ground improvements.....	932, 680. 28	
Maintenance of improvements other than roads, trails, and camp-ground improvements.....	715, 641. 16	
Camp-ground improvements.....	52, 050. 00	
Construction and maintenance of roads and trails—		
10 per cent fund under act of Mar. 4, 1913.....	503, 094. 78	
Cooperative construction of roads and trails under act of July 11, 1916.....	51, 140. 72	
Forest development roads and trails under act of Nov. 9, 1921.....	3, 135, 980. 44	
Forest highways under act of Nov. 9, 1921.....	4, 778, 610. 46	

Administration, protection, improvement, reforestation, and extension of the national forest:—Continued.

Improvement—Continued.

Road and trail construction from moneys contributed by cooperating agencies under act of June 30, 1914.....	\$1, 275, 056. 15
Contributed from other appropriations.....	186, 847. 22

Class total (roads) ..	9, 930, 541. 97
------------------------	-----------------

Subtotal.....	\$11, 631, 101. 21
---------------	--------------------

Reforestation—nurseries and tree planting.....	272, 500. 89
--	--------------

Extension—	
Land exchanges.....	142, 591. 21
Acquisition under act of Mar. 1, 1911, as amended..	2, 025, 839. 27

Subtotal.....	2, 440, 931. 37
---------------	-----------------

Total.....	\$23, 435, 272. 95
------------	--------------------

Protection and reforestation of other than national forest lands—

Tree planting in cooperation with States under act of June 7, 1924.....	81, 035. 69
---	-------------

Fire protection in cooperation with States under act of June 7, 1924.....	1, 330, 875. 96
---	-----------------

Protection of Oregon & California grant lands.....	93, 847. 40
--	-------------

Total.....	1, 505, 759. 05
------------	-----------------

Grand total.....	26, 903, 337. 50
------------------	------------------

In addition to the expenditure for land extension itemized above in the entries "land exchanges" and "acquisition under act of March 1, 1911," national-forest timber having an estimated value of \$454,117 was cut under agreements involving the acquisition of land and timber through exchanges. The cash disbursements recorded under "land exchanges" cover merely the outlay incidental to examining lands offered for exchange and appraising the values involved.

The cash receipts from the national forests were as follows:

From the use of timber.....	\$4, 389, 893. 00
From the use of forage.....	1, 942, 914. 19
From miscellaneous uses, including the use of land, water-power sites, etc.....	418, 746. 03

Total.....	6, 751, 553. 22
------------	-----------------

The total is greater by \$451,751.36 than that for the previous year. Receipts from timber increased \$281,298. Grazing receipts were greater by \$202,624.38 and miscellaneous receipts decreased by \$32,171.02.

In addition to the cash receipts from timber there should be credited the value of the timber cut under specific agreements for effecting land exchanges, estimated at \$454,117.

REPORT OF THE CHIEF OF THE GRAIN FUTURES ADMINISTRATION

UNITED STATES DEPARTMENT OF AGRICULTURE,
GRAIN FUTURES ADMINISTRATION,
Washington, D. C., September 23, 1930.

SIR: I submit herewith a report of the work of the Grain Futures Administration for the fiscal year ended June 30, 1930.

Respectfully,

J. W. T. DUVEL, *Chief.*

HON. ARTHUR M. HYDE,
Secretary of Agriculture.

No formal reports were submitted covering fiscal-year periods between July 1, 1926, and June 30, 1929. In this report, therefore, and for comparative purposes, figures have been included showing the volume of trading by markets for previous years as well as for the past year.

During the past year, as previously, the work of the Grain Futures Administration, while dealing in some degree with virtually every aspect of the grain trade, has been concerned primarily with the supervision of transactions in grain futures on the Nation's grain futures markets. Under the grain futures act, before contracts involving the purchase and sale of grain for future delivery may be entered into by or through members of a grain exchange, such exchange must first comply with certain requirements set forth in the statute and become licensed as a "contract market" by the Secretary of Agriculture. The following statutory conditions must be met by each applicant exchange:

(1) The exchange must be located at a terminal market where cash grain of the kind to be sold for future delivery is sold in sufficient volume and under such conditions as fairly to reflect its general value and the differences in value between the several grades of such grain, and where there is available to such grain exchange official inspection service approved for the purpose by the Secretary of Agriculture.

(2) The governing board of the exchange must provide for the making and filing by the exchange or any member thereof, as directed by the Secretary of Agriculture, of reports, in accordance with the rules and regulations of the Secretary, showing the details and terms of all transactions entered into by the members of the exchange involving both cash grain and grain for future delivery; and must also provide, in accordance with such rules and regulations, for the keeping of a record by the exchange or its members showing the details and terms of all cash and futures transactions, such records to be kept for three years or longer, if directed, and to be open at all times to the inspection of any representative of the Department of Agriculture or the Department of Justice.

(3) The governing board of the exchange must provide for the prevention of the dissemination by the exchange or any member thereof of false or misleading or knowingly inaccurate reports concerning crop or market information or conditions that tend to affect the price of grain in interstate commerce.

(4) The governing board further must provide for the prevention of manipulation of prices and the cornering of any grain by the dealers or operators upon the exchange.

(5) The governing board must not exclude from membership in, and all privileges on, such exchange any duly authorized representative of any lawfully formed and conducted cooperative association of producers having adequate financial responsibility engaged in the cash grain business, if such cooperative association has complied, and agrees to comply, with such terms and conditions as are or may be imposed lawfully on other members of the exchange: *Provided*, That no rule of such exchange shall be construed to prohibit dividends to bona fide members of such cooperative association upon a patronage basis.

FOURTEEN CONTRACT MARKETS

The designation by the Secretary of Agriculture of the Omaha Grain Exchange as a "contract market" on May 22, 1930, increased the total number of such markets in the United States to 14, as follows:

Board of Trade of the City of Chicago (commonly known as the Chicago Board of Trade).

Chicago Open Board of Trade.

Minneapolis Chamber of Commerce.

Kansas City Board of Trade.

Duluth Board of Trade.

St. Louis Merchants Exchange.

Milwaukee Chamber of Commerce.

New York Produce Exchange (inactive as a futures market).

Seattle Grain Exchange.

Portland Grain Exchange.

Omaha Grain Exchange.

Grain Trade Association of the San Francisco Chamber of Commerce.

Los Angeles Grain Exchange.

Baltimore Chamber of Commerce (inactive as a futures market).

Futures trading on the San Francisco and Los Angeles exchanges is confined to transactions in barley futures.

HUGE VOLUME OF TRADING

During the year just closed the total volume of trading in grain futures on these contract markets amounted to slightly less than 25,000,000,000 bushels. Transactions in wheat futures alone during the 12 months aggregated nearly 20,000,000,000 bushels, the greatest for this grain of any year of which we have record. The largest volume of trading for any one day of the year occurred July 15, 1929. Sales of all grain futures on the Chicago Board of Trade that day total 193,479,000 bushels. Another record for the year on the Chicago Board of Trade was established October 24, 1929. On that day sales of Chicago wheat futures aggregated 156,126,000 bushels, the largest volume for any single day thus far recorded by the Grain Futures Administration and 6,539,000 bushels larger than the number on the next largest day, which was July 15 of the same year.

The total volume of trading in all grain futures on the Chicago Board of Trade for the year reached 21,299,395,000 bushels, one of the greatest annual volumes in history; while all records for volume

were broken on the Minneapolis and Kansas City exchanges, which markets rank second and third in point of total volume of trading. Transactions at Minneapolis in all grain futures slightly exceeded 1,500,000,000 bushels. Transactions at Kansas City aggregated 1,074,000,000 bushels, surpassing by 182,000,000 bushels the 892,-000,000-bushel figures of the year ended June 30, 1925, which was the largest previous year's trading at that market since the Grain Futures Administration started receiving reports in 1922.

The aggregate annual volume of trading in wheat, corn, oats, rye, barley, and flax futures for each of the contract markets during the year just ended is shown in Table 1. Table 2 presents the average, maximum, and minimum daily volume of trading in grain futures on the Chicago Board of Trade during the past year, and the dates when the greatest and smallest day's trading in each grain future occurred. The monthly volume of trading in wheat and corn futures at each of the contract markets where these futures are traded in is shown in Tables 3 and 4, respectively. Table 5 shows the volume of trading in each of the contract markets, separately and combined, for all grains, by fiscal years since July 1, 1921.

TABLE 1.—Total volume of trading in grain futures on the contract markets during the fiscal year ended June 30, 1930

[In thousands of bushels; i. e., 000 omitted]

Market	Wheat	Corn	Oats	Rye	Barley	Flax	All grains
Chicago Board of Trade.....	16, 598, 849	3, 346, 544	813, 560	540, 442	-----	-----	21, 299, 395
Chicago Open Board of Trade.....	465, 851	92, 098	6, 128	400	-----	-----	564, 477
Minneapolis Chamber of Commerce.....	1, 248, 091	-----	115, 785	52, 108	96, 182	17, 361	1, 529, 527
Kansas City Board of Trade.....	874, 990	198, 528	-----	-----	-----	-----	1, 073, 518
Duluth Board of Trade.....	328, 109	-----	-----	48, 106	751	20, 853	397, 819
St. Louis Merchants Exchange.....	22, 237	4, 297	-----	-----	-----	-----	26, 534
Milwaukee Chamber of Commerce.....	39, 264	26, 358	10, 075	3, 204	-----	-----	78, 901
Seattle Grain Exchange.....	14, 405	-----	-----	-----	-----	-----	14, 405
Portland Grain Exchange.....	14, 970	-----	-----	-----	-----	-----	14, 970
Omaha Grain Exchange ¹	24	60	-----	-----	-----	-----	84
San Francisco Chamber of Commerce.....	-----	-----	-----	-----	12	-----	12
Los Angeles Grain Exchange.....	-----	-----	-----	-----	8	-----	8
Total.....	19, 606, 790	3, 667, 885	945, 548	644, 260	96, 953	38, 214	24, 999, 650

¹ Trading in grain futures on the Omaha Grain Exchange began June 16, 1930.

TABLE 2.—Average, maximum, and minimum daily volume of trading in grain futures on the Chicago Board of Trade during the fiscal year ended June 30, 1930 with dates when largest and smallest day's trading in each grain future occurred

[In thousands of bushels; i. e., 000 omitted]

Grain	Average daily volume of trading	Largest volume of trading in single day		Smallest volume of trading in single day	
		Bushels		Bushels	
Wheat.....	54, 963	156, 126	Oct. 24, 1929	16, 312	May 24, 1930
Corn.....	11, 081	31, 121	July 17, 1929	3, 183	Oct. 5, 1929
Oats.....	2, 694	11, 944	July 29, 1929	413	Jan. 8, 1930
Rye.....	1, 790	6, 998	Mar. 21, 1930	276	Sept. 13, 1929
Total.....	70, 528	193, 479	July 15, 1929	24, 849	June 7, 1930

TABLE 3.—*Wheat: Monthly volume of trading in wheat futures on each of the contract markets during the fiscal year ended June 30, 1930*

[In thousands of bushels; i. e., 000 omitted]

1929						
Market	July	August	September	October	November	December
Chicago Board of Trade.....	2, 432, 109	1, 895, 818	1, 157, 203	1, 467, 355	1, 500, 480	1, 375, 978
Chicago Open Board of Trade.....	63, 509	50, 997	37, 378	41, 416	32, 918	39, 142
Minneapolis Chamber of Commerce.....	186, 177	149, 911	110, 814	117, 068	127, 480	94, 622
Kansas City Board of Trade.....	151, 205	110, 215	56, 888	73, 728	96, 482	70, 654
Duluth Board of Trade.....	44, 500	48, 631	31, 981	30, 248	37, 324	20, 349
St. Louis Merchants Exchange.....	3, 432	2, 190	1, 426	2, 106	2, 060	1, 939
Milwaukee Chamber of Commerce.....	4, 914	3, 340	2, 599	3, 269	3, 909	3, 435
Seattle Grain Exchange.....	1, 863	1, 935	1, 023	1, 537	1, 793	1, 060
Portland Grain Exchange.....	1, 006	1, 484	1, 352	1, 601	2, 434	1, 127
1930						
	January	February	March	April	May	June
Chicago Board of Trade.....	1, 151, 591	1, 277, 368	1, 028, 026	1, 259, 039	875, 505	1, 178, 377
Chicago Open Board of Trade.....	31, 066	34, 200	30, 083	35, 856	33, 167	36, 119
Minneapolis Chamber of Commerce.....	83, 124	99, 541	75, 277	88, 628	43, 971	71, 478
Kansas City Board of Trade.....	49, 578	53, 857	47, 968	75, 441	32, 381	56, 593
Duluth Board of Trade.....	11, 470	11, 360	15, 062	33, 539	14, 673	28, 972
St. Louis Merchants Exchange.....	2, 103	1, 530	851	2, 775	704	1, 121
Milwaukee Chamber of Commerce.....	3, 375	3, 900	2, 911	2, 925	2, 399	2, 288
Seattle Grain Exchange.....	956	1, 108	631	1, 073	528	898
Portland Grain Exchange.....	1, 181	804	710	1, 433	366	1, 472
Omaha Grain Exchange ¹						24

¹ Trading in grain futures on the Omaha Grain Exchange began June 16, 1930.TABLE 4.—*Corn: Monthly volume of trading in corn futures on each of the contract markets during the fiscal year ended June 30, 1930*

[In thousands of bushels; i. e., 000 omitted]

1929						
Market	July	August	September	October	November	December
Chicago Board of Trade.....	481, 869	418, 505	271, 827	245, 604	237, 727	178, 469
Chicago Open Board of Trade.....	11, 372	10, 576	8, 714	8, 025	6, 771	5, 259
Kansas City Board of Trade.....	22, 771	21, 496	13, 343	13, 075	13, 807	13, 316
St. Louis Merchants Exchange.....	372	316	235	250	295	226
Milwaukee Chamber of Commerce.....	3, 247	1, 791	1, 969	2, 000	2, 006	2, 107
1930						
	January	February	March	April	May	June
Chicago Board of Trade.....	175, 802	224, 553	297, 395	252, 347	265, 421	297, 025
Chicago Open Board of Trade.....	4, 963	6, 886	8, 464	6, 725	6, 940	7, 403
Kansas City Board of Trade.....	12, 394	17, 021	19, 406	20, 606	15, 492	15, 801
St. Louis Merchants Exchange.....	355	702	746	565	90	145
Milwaukee Chamber of Commerce.....	2, 137	2, 420	2, 401	2, 668	1, 871	1, 741
Omaha Grain Exchange ¹						60

¹ Trading in grain futures on the Omaha Grain Exchange began June 16, 1930.

TABLE 5.—Total volume of trading in wheat, corn, oats, rye, barley, flax, and all grain futures on the contract markets by fiscal years, from July 1, 1921, to June 30, 1930

[In thousands of bushels; i. e., 000 omitted]

WHEAT

Market	1922	1923	1924	1925	1926	1927	1928	1929	1930
Chicago Board of Trade	12,814,318	9,625,226	6,124,323	16,587,110	15,869,025	10,619,503	9,203,164	9,907,610	16,598,849
Chicago Open Board of Trade	343,300	354,173	261,833	446,476	601,900	429,296	342,363	387,217	465,851
Minneapolis Chamber of Commerce	594,147	555,396	438,123	927,811	972,544	631,835	824,255	886,970	1,248,091
Kansas City Board of Trade	532,647	340,428	270,842	577,006	546,449	502,492	441,400	575,805	874,990
Duluth Board of Trade	168,817	226,061	142,467	189,576	233,977	154,918	272,492	376,615	328,109
St. Louis Merchants Exchange	178,096	98,448	65,772	126,006	96,569	69,507	53,235	27,561	22,237
Milwaukee Chamber of Commerce	24,316	26,161	13,550	21,980	23,966	20,067	27,602	25,043	39,264
New York Produce Exchange	(1)	(1)	(1)	(1)	(1)	148,830	29,125	7,851	14,405
Seattle Grain Exchange	(1)	(1)	(1)	(1)	(1)	6,892	7,382	362	14,970
Portland Grain Exchange	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	24
Omaha Grain Exchange	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Total	14,655,641	11,225,893	7,316,910	18,875,965	18,345,015	12,583,940	11,201,018	12,195,034	19,606,790
Per cent Chicago Board of Trade is of all markets	87.44	86.74	83.70	87.87	86.50	84.39	82.16	81.24	84.66

CORN

Chicago Board of Trade	4,153,006	4,831,333	3,925,291	7,343,148	3,905,806	4,916,096	7,275,019	5,370,226	3,346,544
Chicago Open Board of Trade	90,072	100,121	130,439	148,672	85,915	151,558	178,244	153,625	92,098
Minneapolis Chamber of Commerce	6,514	1,897	3						
Kansas City Board of Trade	145,591	168,551	182,695	310,716	168,182	169,452	293,580	259,569	198,528
St. Louis Merchants Exchange	42,062	53,901	55,891	61,209	19,262	16,364	32,047	14,108	4,297
Milwaukee Chamber of Commerce	25,524	22,359	16,592	20,924	13,036	24,183	39,558	33,552	26,358
Omaha Grain Exchange									60
Total	4,462,769	5,178,162	4,310,911	7,884,699	4,192,201	5,277,653	7,818,448	5,831,080	3,667,885
Per cent Chicago Board of Trade is of all markets	93.06	93.30	91.05	93.13	93.17	93.15	93.05	92.10	91.24

TABLE 5.—*Total volume of trading in wheat, corn, oats, rye, barley, flax, and all grain futures on the contract markets by fiscal years, from July 1, 1921, to June 30, 1930—Continued*

[In thousands of bushels; i. e., 000 omitted]

OATS

Market	1922	1923	1924	1925	1926	1927	1928	1929	1930
Chicago Board of Trade	2, 151, 477	1, 126, 072	686, 504	2, 984, 591	1, 064, 143	1, 158, 433	1, 108, 286	611, 070	813, 560
Chicago Open Board of Trade	28, 834	7, 660	7, 128	18, 441	5, 981	14, 608	13, 894	4, 661	6, 128
Minneapolis Chamber of Commerce	208, 549	137, 475	67, 205	293, 396	272, 847	215, 724	135, 945	68, 835	115, 785
Kansas City Board of Trade	11, 942	2, 735	2, 043	4, 200	3, 771	1, 565	40		
St. Louis Merchants Exchange	2, 770	1, 345							
Milwaukee Chamber of Commerce	21, 759	9, 007	8, 301	17, 597	9, 929	16, 492	10, 883	7, 753	10, 075
New York Produce Exchange						665			
Total	2, 425, 331	1, 284, 294	771, 181	3, 318, 225	1, 356, 671	1, 407, 487	1, 269, 048	692, 319	945, 548
Per cent Chicago Board of Trade is of all markets	88. 71	87. 68	89. 02	89. 95	78. 44	82. 31	87. 33	88. 26	86. 04

RYE

Chicago Board of Trade	212, 554	403, 046	236, 290	1, 027, 644	469, 248	469, 042	396, 490	359, 823	540, 442
Chicago Open Board of Trade		19	125	1, 700	327	1, 231	206	339	400
Minneapolis Chamber of Commerce	20, 728	73, 771	93, 509	78, 453	72, 834	65, 436	36, 163	34, 909	52, 108
Duluth Board of Trade	30, 650	120, 776	84, 130	117, 875	62, 691	64, 958	76, 137	44, 001	48, 106
Milwaukee Chamber of Commerce	1, 171	2, 884	3, 461	3, 085	4, 660	5, 530	3, 632	3, 344	3, 204
Total	265, 103	600, 496	417, 515	1, 228, 757	609, 760	606, 197	512, 628	442, 416	644, 260
Per cent Chicago Board of Trade is of all markets	80. 18	67. 12	56. 59	83. 63	76. 96	77. 37	77. 34	81. 33	83. 89

BARLEY

Chicago Board of Trade	1, 894	439	180	34, 766	43, 758	29, 147	43, 009	77, 334	96, 182
Minneapolis Chamber of Commerce	18, 326	15, 645	8, 316		1, 636	360	601	4, 568	751
Duluth Board of Trade									
Milwaukee Chamber of Commerce	40	9	3, 005	3, 438	166	8	16	8	12
San Francisco Chamber of Commerce			294	205	164	168	218	143	8
Los Angeles Grain Exchange									
Total	20, 260	16, 093	11, 795	38, 409	45, 724	29, 683	43, 844	82, 053	96, 953
Per cent Chicago Board of Trade is of all markets	9. 35	2. 73	1. 53						

FLAX

Minneapolis Chamber of Commerce.....	13, 162	7, 600	13, 017	16, 504	21, 338	22, 706	25, 418	27, 397	17, 361
Duluth Board of Trade.....	22, 673	19, 427	26, 819	53, 621	34, 373	36, 203	33, 137	20, 670	20, 853
Total.....	35, 835	27, 027	39, 836	70, 125	55, 711	58, 909	58, 555	48, 067	38, 214

ALL GRAINS COMBINED

Chicago Board of Trade.....	19, 333, 249	15, 986, 116	10, 972, 588	27, 942, 493	21, 308, 222	17, 163, 074	17, 982, 959	16, 248, 729	21, 299, 395
Chicago Open Board of Trade.....	462, 206	461, 973	399, 525	615, 289	694, 123	596, 693	534, 707	545, 842	564, 477
Minneapolis Chamber of Commerce.....	861, 426	791, 784	620, 173	1, 350, 930	1, 383, 321	964, 848	1, 064, 790	1, 095, 445	1, 529, 527
Kansas City Board of Trade.....	690, 180	511, 714	455, 580	891, 922	718, 402	673, 509	735, 020	835, 374	1, 073, 518
Duluth Board of Trade.....	222, 140	366, 264	253, 416	361, 072	332, 677	256, 439	382, 367	445, 854	397, 819
St. Louis Merchants Exchange.....	222, 928	153, 694	121, 663	187, 215	115, 831	85, 871	85, 282	41, 669	26, 534
Milwaukee Chamber of Commerce.....	72, 810	60, 420	41, 904	63, 586	51, 591	66, 872	81, 675	69, 692	78, 901
New York Produce Exchange.....	-----	-----	-----	-----	-----	149, 495	29, 125	-----	-----
Seattle Grain Exchange.....	-----	-----	-----	-----	-----	6, 892	7, 382	7, 851	14, 405
Portland Grain Exchange.....	-----	-----	-----	-----	-----	-----	-----	362	14, 970
Omaha Grain Exchange.....	-----	-----	-----	-----	-----	-----	-----	-----	84
San Francisco Chamber of Commerce.....	-----	-----	3, 005	3, 438	166	8	16	8	12
Los Angeles Grain Exchange.....	-----	-----	294	205	164	168	218	143	8
Total.....	21, 864, 939	18, 331, 965	12, 868, 148	31, 416, 150	24, 605, 082	19, 963, 869	20, 903, 541	19, 290, 969	24, 999, 650
Per cent Chicago Board of Trade is of all markets.....	88. 42	87. 20	85. 27	88. 94	86. 60	85. 97	86. 03	84. 23	85. 20

¹ No trading in grain futures in New York prior to August, 1926; Seattle prior to May, 1926; Portland prior to June, 1929; Omaha prior to June, 1930. No trading in Baltimore at any time during the period.

WHEAT PRICES DECLINE

The large volume of trading in wheat futures during the past fiscal year was not the result of any unusual speculative activity such as is most frequently associated with scarcity and advancing prices. On the contrary, prices showed a general downward course, being lower by approximately 60 cents per bushel on June 30, 1930, than they were in the latter part of July, 1929. Buying support during the year came largely from the so-called general public, composed of small traders who apparently had hopes of higher prices, whereas the large speculators as a class operated primarily on the short side of the market. The large volume of trading is accounted for in part by hedging against the larger stocks of wheat and by speculative participation in the market early in the year by small traders, who were expecting higher prices.

ALL TRADING REPORTED

The amount of grain bought and sold for future delivery, totaling for the year practically 25,000,000,000 bushels, was reported daily by the clearing members of the several grain exchanges to the exchange supervisors in charge of field offices of the Grain Futures Administration. These field offices are now located at many of the principal contract markets; namely, Chicago, Ill.; Minneapolis, Minn.; Kansas City, Mo.; Seattle, Wash.; and Sacramento, Calif. The latter office exercises supervision over the Grain Trade Association of the San Francisco Chamber of Commerce and the Los Angeles Grain Exchange. The Seattle office was established during the past year as a partial means of providing more effective service to the producers, shippers, terminal-elevator operators, millers, and exporters of the Pacific Northwest. An appropriation measure carrying an item for necessary funds for the establishment of a field office at Omaha was pending in the Congress at the close of the year just ended. Funds were made available soon thereafter and an office opened July 16, one month after trading in grain futures was inaugurated on the Omaha Grain Exchange.

INFORMATION FURNISHED DAILY

The Grain Futures Administration during the past year has continued the daily announcement, through press associations, newspapers, and trade journals, of the amount of open commitments in grain futures at the principal markets for the preceding day. The administration has since January, 1924, announced daily the volume of trading on the principal contract markets. The additional publication of the daily open commitments or open interest (the aggregate of contracts remaining unfilled by the delivery of grain or not closed by an offsetting purchase or sale) was begun in August, 1928. The announcement daily of this information was attended by considerable misgiving on the part of certain members of the grain trade. It was the belief of the administration, however, that the

many interests and agencies employing futures trading facilities for hedging purposes would be enabled to conduct their hedging operations much more intelligently if they could be informed at all times concerning the amount of contracts open in the various futures. Theretofore hedgers had been entirely without such information and as a result were compelled to grope about in the dark so far as knowledge of conditions respecting a particular future was concerned. The benefits flowing from the daily publication of this information during the past two years have amply justified what was viewed by many in the grain trade at the time of its adoption as a dangerous innovation.

The amount of open commitments in each wheat and corn future on the Chicago Board of Trade at semimonthly intervals during the period June 29, 1929, to June 30, 1930, is shown in Tables 6 and 7, respectively. The largest amount in open commitments ever recorded for all wheat futures on the Chicago Board of Trade was reached during the past year: 248,294,000 bushels on October 16, 1929.

TABLE 6.—Wheat: Amount of open commitments in the various wheat futures on the Chicago Board of Trade shown semimonthly for the period June 29, 1929, to June 30, 1930 ¹

[In thousands of bushels; i. e., 000 omitted]

Date	Future					
	July	September	December	March	May	All wheat futures
1929						
June 29.....	12, 698	83, 621	43, 363	-----	90	139, 772
July 15.....	3, 182	91, 068	69, 764	-----	425	164, 439
July 31.....	-----	87, 201	119, 670	1, 742	1, 650	210, 263
Aug. 15.....	-----	60, 261	130, 070	4, 228	22, 983	217, 542
Aug. 31.....	-----	18, 368	147, 172	5, 892	44, 118	215, 550
Sept. 14.....	-----	5, 042	157, 187	7, 334	55, 407	224, 970
Sept. 30.....	-----	-----	162, 228	8, 045	73, 064	243, 337
Oct. 15.....	-----	-----	153, 715	7, 990	84, 596	246, 301
Oct. 31.....	-----	-----	118, 786	9, 698	92, 111	220, 595
Nov. 15.....	1, 772	-----	84, 145	13, 846	98, 134	197, 897
Nov. 30.....	5, 880	-----	26, 379	17, 457	140, 023	189, 739
Dec. 14.....	10, 183	-----	4, 370	19, 006	154, 894	188, 453
Dec. 31.....	14, 722	-----	-----	18, 574	150, 898	184, 194
1930						
Jan. 15.....	19, 864	-----	-----	18, 006	158, 206	196, 076
Jan. 31.....	25, 956	4, 641	-----	15, 144	155, 686	201, 427
Feb. 15.....	25, 934	8, 389	-----	11, 612	148, 073	194, 008
Feb. 28.....	30, 349	11, 869	-----	6, 674	129, 011	177, 903
Mar. 15.....	38, 575	17, 962	5	828	115, 955	173, 325
Mar. 31.....	43, 469	19, 883	30	-----	104, 963	168, 345
Apr. 15.....	50, 929	22, 694	3, 767	-----	87, 209	164, 599
Apr. 30.....	65, 929	29, 554	12, 266	-----	32, 574	140, 323
May 15.....	66, 173	36, 112	16, 646	-----	13, 526	132, 457
May 31.....	64, 741	38, 755	21, 433	-----	-----	124, 929
June 14.....	52, 634	48, 474	25, 933	-----	-----	127, 041
June 30.....	14, 082	55, 597	35, 492	-----	-----	105, 171

¹ The maximum open commitments in all wheat futures was 248,294,000 bushels on Oct. 16, 1929. The minimum was 105,171,000 bushels on June 30, 1930.

TABLE 7.—*Corn: Amount of open commitments in the various corn futures on the Chicago Board of Trade shown semimonthly for the period June 29, 1929, to June 30, 1930*¹

[In thousands of bushels; i. e., 000 omitted]

Date	Future						
	July	Septem- ber	Decem- ber	March	May	Other	All corn futures
1929							
June 29.....	11, 663	21, 678	15, 098	-----	-----	-----	48, 439
July 15.....	2, 468	24, 950	21, 002	-----	-----	-----	48, 420
July 31.....	-----	23, 907	26, 423	245	-----	-----	50, 575
Aug. 15.....	-----	18, 453	23, 452	1, 543	770	-----	44, 218
Aug. 31.....	-----	9, 919	29, 598	2, 905	4, 556	-----	46, 978
Sept. 14.....	-----	6, 640	30, 900	3, 186	6, 171	-----	46, 897
Sept. 30.....	-----	-----	30, 684	4, 679	9, 002	20	44, 385
Oct. 15.....	-----	-----	28, 665	4, 613	10, 050	5	43, 333
Oct. 31.....	-----	-----	22, 640	4, 940	11, 354	-----	38, 934
Nov. 15.....	-----	-----	17, 184	5, 333	11, 563	-----	34, 080
Nov. 30.....	315	-----	11, 666	6, 252	15, 813	-----	34, 046
Dec. 14.....	1, 093	-----	7, 649	6, 490	18, 763	-----	38, 995
Dec. 31.....	2, 314	-----	-----	7, 080	20, 795	-----	30, 189
1930							
Jan. 15.....	3, 262	-----	-----	6, 802	23, 511	-----	33, 575
Jan. 31.....	6, 633	598	-----	5, 593	25, 928	-----	38, 752
Feb. 15.....	9, 133	1, 825	-----	5, 001	29, 024	-----	44, 983
Feb. 28.....	11, 091	3, 944	-----	2, 353	28, 327	-----	45, 715
Mar. 15.....	15, 379	7, 170	-----	344	27, 822	-----	50, 715
Mar. 31.....	17, 468	8, 680	25	-----	26, 909	-----	53, 082
Apr. 15.....	21, 677	9, 538	1, 585	-----	16, 807	-----	49, 607
Apr. 30.....	25, 788	11, 849	3, 450	-----	7, 260	-----	48, 347
May 15.....	25, 449	15, 396	4, 778	-----	3, 048	-----	48, 671
May 31.....	24, 698	17, 277	6, 915	-----	-----	-----	48, 890
June 14.....	19, 200	19, 339	7, 559	-----	-----	-----	46, 098
June 30.....	10, 924	18, 610	8, 372	-----	-----	-----	37, 906

¹ The maximum open commitments in all corn futures was 53,301,000 bushels on Mar. 29, 1930. The minimum was 30,189,000 bushels on Dec. 31, 1929.

FRAUDULENT SCHEMES

In the work of enforcing the grain futures act various fraudulent schemes and devices are encountered to mulct the credulous everywhere by the promise of attractive profits with comparative safety through the purchases from the promoters of "price guaranties," "spreads," etc., profits for the patron to be determined by the extent of fluctuations in grain prices. The administration cooperates closely with the Post Office Department and the Department of Justice in the investigation of such activities, and assists in the prosecution of violators of the postal laws where operations of this character are involved.

What was perhaps the most important case of this type in recent years, and one in which the administration had participated from its inception, and was keenly interested, was brought to a close during the past year when the circuit court of appeals of the eighth circuit affirmed the conviction of the defendant in the case of *United States v. Schauble*.

Following the indictment of the accused by the Federal grand jury at Kansas City, Mo., he was convicted in the United States District Court for the Western District of Missouri on each of the seven counts of the indictment. The indictment charged that the defendant had devised a scheme for obtaining money by means of false and fraudulent representations, pretenses, and promises from all

persons throughout the United States whom the defendant could induce to entrust to him their money and property—

under the name of Investors Daily Guide for the purchase of so-called advance guaranties, decline guaranties, and spread guaranties based on and relating to the fluctuation in price of grain, wheat, corn, and oats in the future and to convert said money and property to his own use without giving or intending to give to said persons to be defrauded anything of an equivalent value therefor.

The evidence adduced at the trial described the scheme employed by the promoter as follows:

Customers would pay the defendant through the so-called Investors Daily Guide \$12.50 for an advance guaranty, or a decline guaranty and \$25 for a spread guaranty including both an advance and a decline in one contract. In return for his money the customer received a contract usually effective for one week and covering 10,000 bushels of grain. In this contract the defendant agreed to pay the customer 1 cent per bushel for each cent the market fluctuated above or below the price designated in the advance or decline, respectively. The spread guaranty was designed to cover both an advance and a decline in a single contract. The designated price above or below which the market might fluctuate with profit to the customer was determined by the proprietor of the Investors Daily Guide and, though supposed to be established with relation to the market price when the contract was issued, it was, in reality, placed so far above or below prevailing prices as to eliminate all probability of the market's fluctuating sufficiently during the contract period to return any profit to the patron. Upon conviction in the trial court the promoter of this enterprise received a sentence of four years' imprisonment in a Federal penitentiary together with a fine of \$1,750. Sentence was affirmed April 16, 1930, by the Circuit Court of Appeals. (40 Fed. (2d) 363.)

REPORT TO SENATE

The special report to the Senate relative to the effect of the suspension in 1927 of the requirement of daily reports showing the net trading position of the large futures traders was concluded during the past year. The preparation of this report involving a vast amount of investigative, analytical, and statistical work by the staff of the administration was directed by Senate Resolution No. 40 of the Seventieth Congress. The administration always has regarded the daily reports upon operations of large traders, dispensed with for an 8-month period in 1927, as essential to effective regulation of the futures markets and as being necessary to prevent manipulation of grain prices. Unfortunately, this view was not shared by all interests in the speculative grain trade, and statements and reports were circulated to the effect that these reports to the Grain Futures Administration were keeping large speculators from operating in the wheat futures market who otherwise would be heavy buyers and whose support, if the reports were dispensed with, would result in higher prices to producers.

Most of the known large speculators had been in the markets at the very time these claims were being pressed most urgently, but without an actual test it could not be determined definitely how many known interests there might be who would enter the markets if the

reporting requirement was suspended. When the principal grain exchanges themselves were persuaded into reporting officially to the Secretary of Agriculture early in 1927 that the reports in question were responsible for the low price of wheat and that improvement would result if they were not required, the then Secretary of Agriculture decided that the most satisfactory way of determining the facts was by actual trial and demonstration. Accordingly, the reports were dispensed with effective February 26, 1927, and were not again required until November 1, 1927.

The administration's investigation disclosed that during the eight months the reports were dispensed with the greatest number of speculators large enough to be affected by the reporting requirement that were in the Chicago market at one time was 39, and that while, during January and February prior to the suspension, there had been six days when an equal number of speculators large enough to be reported were in the wheat market at the same time, during the entire eight months the reports were dispensed with there were but two days when as many as 39 were in the market at the same time.

The investigation further disclosed that during the period of suspension there were seven speculators who acquired a net position in all Chicago wheat futures of at least 2,000,000 bushels. Six of these seven were in the market before the reporting requirement was suspended, but, instead of supporting the market, each of the seven was short when the reports were dispensed with and had been for some time. One of these seven came in later on the long side but was not a new trader.

Considered collectively the group of 7 had a short position in the wheat market during 6 of the 8 months of the suspension, and but 1 of the 7 did any buying for long account immediately following the suspension, and he was on the long side for only a few days before selling his holdings. This group of seven, which, considered collectively, was net short slightly more than 7,000,000 bushels February 25, the day before the suspension, practically doubled its short commitments by April 19, when it was 13,400,000 bushels net short.

Part 1 of the special report concerning the effect of the reporting requirement suspension was transmitted to the Senate during the preceding fiscal year, and published as Senate Document No. 264, Seventieth Congress. The second and concluding part of the report, completed during the past year, has been published as Senate Document No. 123, Seventy-first Congress. This report presents an exhaustive analysis of the trading operations of the various classes of traders, including the larger speculators in wheat and corn futures, during the period January 3 to October 31, 1927, and contains considerable statistical and tabular material relating to trading in wheat and corn futures during that period.

During the past year, despite the fact that the volume of trading was larger as a whole than usual and despite the evidence secured as a result of the investigation under Senate Resolution 40, suggestions have again been forthcoming from certain sources to the effect that a suspension of the reporting requirement under the grain futures act would encourage speculative buying and result in higher prices for wheat. It is not known by what magical process wheat

prices could be boosted if the Government were blindfolded, so to speak, during the course of the boosting operations, nor has any explanation been offered to show why the same process could not be used to depress prices as well. Certainly there has been no disposition on the part of any governmental agency to discourage the legitimate buying of wheat during the past year. If, by these suggestions, however, it is meant to convey the idea that without the reporting requirement speculators could manipulate prices upward, the answer is that the duty to prevent price manipulation, imposed by the grain futures act upon the Secretary of Agriculture and upon grain exchanges licensed under the act, is no less sacred as regards manipulation upward than it is as regards manipulation downward. The futures markets must reflect true supply and demand conditions at all times if they are to serve the needs of agriculture equally with those of the consuming public.

SPECIAL INVESTIGATIONS

The data gained by the administration through the medium of daily reports with respect to volume of trading, open interest, and the character and extent of the holdings of the larger operators are supplemented by continuous observation of activities on most of the larger exchanges, and by special investigations conducted from time to time by operatives of the administration.

As a result of practices involving the very fundamentals of futures trading which were unearthed by an investigation of trading irregularities on contract markets initiated by the Grain Futures Administration during the past year, formal complaints have been filed by the Secretary of Agriculture against three members of the Chicago Board of Trade. These complaints allege numerous violations of the grain futures act by the respondents, incident to their alleged manipulation of the price of grain on the Chicago Board of Trade through the purchase and sale during a 3-week period of not less than 345,000 bushels of the December wheat future at prices, in some instances, as much as 2 cents per bushel higher and lower than the actual market price. Other violations alleged include the transmission through the mails and by telegraph of false and misleading information tending to affect the price of grain in interstate commerce; and the failure to keep records of transactions as required under the grain futures act.

Formal hearings upon these complaints, directing the accused brokers to show cause why an order should not be issued directing all contract markets to refuse the respondents all trading privileges thereon, have been held at Chicago before a referee representing the commission created by the grain futures act (consisting of the Secretary of Agriculture, chairman; Attorney General; and Secretary of Commerce). Further proceedings were pending at the close of the year just ended.

Other investigations during the year included a brief survey of conditions at the Omaha market incident to the operation of the rules of the Omaha Grain Exchange requiring the transfer (unloading) at that market for weighing of all grain sold on the Omaha exchange or bought "to arrive" at that market by exchange members

and diverted elsewhere. The survey of the operation of Chicago's terminal elevators involving the receipt and shipment of grain, with especial reference to the mixing or disappearance of certain grades of grain in storage, was resumed and is now in progress. Examinations of the books and records of private-wire houses at the larger markets at intervals during the year disclosed that the general public, known in the parlance of the grain trade as the "country" as distinguished from members of the trade and professional operators, were on the long side of the wheat market overwhelmingly, and that the proportion of small traders dealing in job lots (less than 5,000 bushels) was far greater than the percentage trading in round lots (5,000 bushels and multiples thereof).

PRIVILEGE TRADING

The importance of trading in privileges, otherwise known as puts and calls, is becoming increasingly evident. While for the most part trading in privileges appeals to small traders unable to finance trades in futures proper, it also furnishes opportunity and is used by large speculators frequently to change their market position without the trades being made in the grain pits.

At the time the grain futures act was approved, September 21, 1922, trading in privileges in grain was presumably stopped by a prohibitive tax under section 3 of the future trading act. Since that time, however, the Supreme Court in *Trusler v. Crooks* (269 U. S. 478) has held this section of the future trading act to be unconstitutional for the same reason that other sections of the act were held unconstitutional in *Hill v. Wallace* (259 U. S. 44), and privilege trading has been resumed. Some exchanges, including the Winnipeg Grain Exchange and the New York Cotton Exchange, prohibit trading in privileges by members. Indeed, these transactions are prohibited as gambling transactions under the laws of many of the States. Because of the important part played by these transactions on the Chicago Board of Trade in futures as a whole, it will be necessary, if this type of dealing shall continue, for the Grain Futures Administration to extend its reporting requirements to cover trading in privileges. It is a serious question whether trading in privileges should be sanctioned in the same sense that dealing in futures is sanctioned under the grain futures act as an aid to interstate commerce in grain. On the other hand, there can not be complete and effective supervision over trading in futures unless it extends also to privilege trading. Privilege trading is one of several projects which are being given major consideration and study at the present time. These studies may possibly present privilege trading in a different light from that in which such trading is commonly regarded at the present time.

AMENDMENT OF ACT

As a result of the past seven years' experience in the enforcement of the grain futures act the administration is convinced that the enactment of strengthening amendments to the present law would make possible more effective regulation of the grain futures markets and would tend to insure the movement of grain prices more closely

in accordance with true conditions of supply and demand. Of the amendments deemed desirable perhaps the most salutary, in the opinion of the administration, would be the imposition of a rational limitation upon the volume of daily purchases or sales and the total futures holdings permitted a trader for speculative purposes. Under the present act the administration has no authority whatever to limit in any wise the volume of a speculator's trading or total commitments in the absence of evidence of manipulation. Investigations of the futures markets by the administration have disclosed a great many cases wherein prices have moved in line with heavy concentrated trading of a purely speculative character. It is the conviction of the administration that a rational limitation of such trading would inure to the direct benefit of all interests using the futures markets for proper purposes. A bill providing such an amendment, together with other amendments, was reintroduced in the present Congress and was pending in committee at the close of the year.

PUBLICATIONS

In addition to Part 2 of the special report to the Senate under Senate Resolution No. 40, Seventieth Congress, printed as Senate Document No. 123, Seventy-first Congress, to which previous reference has been made, other publications have been prepared during the year, as follows: Hedging in Grain Futures, a study of hedging practice for country elevators by J. M. Mehl, which is ready for the press; and Trading in Corn Futures by G. Wright Hoffman, was completed and transmitted to the printer for publication as a technical bulletin. A statistical bulletin summarizing statistical data compiled by the administration relative to trading in wheat futures since January 1, 1921, has been completed and is now in press. The data presented include the volume of trading, open commitments, and prices of wheat futures from January 1, 1921, to December 31, 1929. A similar bulletin dealing with trading in corn futures was in process of preparation at the close of the year. The manuscript of a guide book to domestic grain trade statistics has been prepared by H. S. Irwin, and an early release of this report is planned.

REPORT OF THE CHIEF OF THE BUREAU OF HOME ECONOMICS

UNITED STATES DEPARTMENT OF AGRICULTURE,
BUREAU OF HOME ECONOMICS,
Washington, D. C., August 1, 1930.

SIR: I present herewith the report of the Bureau of Home Economics for the fiscal year ended June 30, 1930.

Respectfully,

LOUISE STANLEY, *Chief.*

HON. ARTHUR M. HYDE,
Secretary of Agriculture.

The work of the bureau has proceeded along the general lines outlined in my last annual report.

The demand for cooperation with outside agencies has been exceedingly great. Cooperation with the Washington Child Research Center has continued. I have served as chairman of the advisory committee and have supervised the work of a nutritionist from our staff placed there to study problems of child nutrition. A special study has been made of relation of diet to time and soundness of sleep. We have cooperated in the analysis of data on diet collected from certain isolated Virginia communities.

A request came to this bureau for help in planning diets in several Federal prisons. Conferences were held in regard to the selection of a person to make a preliminary study as a basis for recommendations for needed changes. Since a man was preferred for this job, it did not seem wise to detail any one from this bureau. We have kept in touch with this work, advised from time to time, and furnished recipes on request, working out special recipes to meet the particular needs. The laboratory facilities made available by moving to the Earle Building will increase the possibilities of this cooperation.

I have served as a member of the planning committee of the White House Conference on Child Health and Protection appointed by the President, July, 1929, and have also served as chairman of the committee on the family and parent education. Other members of the staff have served on different advisory committees of this conference. Time has been required for committee meetings and discussion and preparation of reports. Through the conference a research assistant and a clerk have both been made available, who have handled much of the work under direction. The committee, of which I am chairman, has been divided into six subcommittees

with a total membership of 29, who work with specially appointed advisory committees to make up a total of 89 members.

These six subcommittees are collecting data on the family, the activities of the family, and the part they play in the education of children in the home. Through the active cooperation of the members of the committee on the family of the Social Science Research Council, considerable data have been collected on the family, especially in relation to the part it plays in the education of the child. These data have been so organized as to be of value to home economics workers.

A schedule for the study of family situations has been prepared. This will make it possible for workers to collect data which will contribute to the solution of some of the changing social problems and will show the relation of these to the more exact data on standards of living and household production being accumulated as a part of the work of this bureau.

Of special interest will be the reports of the subcommittee considering the adaptation of housing and equipment to the needs of children and the subject of household budgets and labor problems of the household as they must be modified to provide satisfactory conditions and meet the growing needs of children in the home. This subcommittee is subdivided into several smaller committees, each working with a different group of experts, some from Better Homes in America and the American Housing Association, some from land-grant colleges, and others from the staff of this bureau.

Three of the subcommittees are collecting and summarizing material on parent education. In this work the Bureau of Home Economics is cooperating with the National Council of Parent Education, the Office of Education of the United States Department of the Interior, and with various professional and lay organizations handling specialized phases of parent education. As the result of the efforts of these committees and the advisory groups working with them there will be compiled a list of all agencies working in parent education, with a brief analysis of the work of each; a selected list of references to subject matter which might well be used in parent education; and three monographs will also be prepared dealing with the general philosophy underlying parental and preparental education, illustrating types of organization and method by descriptions of specific pieces of work already under way. The foremost workers in each field have contributed to these studies. This material will be of special interest to extension workers, since they are being made increasingly responsible for instruction in child development in the rural home.

While this committee work has been time consuming, we feel that it has been more than worth while in the material it has brought together, the contacts it has made possible, and the cooperative relations which have been established between home economics workers and other groups. It has helped the workers in other fields to appreciate the contribution of home economics, and has given home economics workers a wider vision of their field in relation to the various governmental and lay activities contributing to the welfare of the child.

Members of this bureau have served on several committees of the American Standards Association, working toward the establishment of standards for consumers' goods in cooperation with representatives of manufacturers and distributors. In so far as possible, studies of the bureau have been modified in order to develop factual material for these studies.

It is realized that any program for standard specifications must be based upon detailed knowledge of the equipment in use and of the extent to which it is adapted to the needs of the housewife. Such basic facts given to manufacturers will assist them in their efforts to meet the needs of the consumer and to modify their products accordingly. At the same time the consumer must be educated in the wise selection and use of this equipment. Standard specifications will be of little value unless the housewife understands their basis and knows how to use household equipment in accordance with the specifications.

FOODS AND NUTRITION

In the foods and nutrition division the work is continuing under the three sections: Proximate composition of foods, nutrition studies, and food utilization and preservation.

PROXIMATE COMPOSITION OF FOODS

New summary tables on the proximate composition of 121 classes and varieties of fresh vegetables have been completed, and are in press. With the increase in the variety of fresh vegetables in the American dietary there has been a growing demand from nutrition workers for reliable data on the chemical composition of certain vegetables not included in the older standard food-composition tables. This publication will help to meet this demand and at the same time will provide further information on some of the vegetables included in the older tables.

In the 30 years since the standard tables on proximate composition of foods were issued many vegetables such as broccoli, globe artichokes, Chinese cabbage, and dasheens have gained in popularity. To provide nutrition workers with a satisfactory basis for calculating the composition of these foods in the diet it has been necessary to make a careful search through the literature for suitable analyses. These have been examined critically and supplemented by unpublished records of the United States Department of Agriculture and other cooperating agencies. In a few cases arrangements have been made to have much needed determinations made for the purpose.

In preparing these new summary tables careful attention has been given to the representative character of the chemical samples. The selection and classification of the data have been worked out with the assistance of botanists, plant physiologists, and horticultural specialists who were most familiar with the particular food plant concerned.

The new tables indicate the extent of variations in the composition of individual samples as well as give the average figures. These should provide nutrition workers some measure of the accuracy of the average figures when they use them to calculate the composition of a particular food.

NUTRITION STUDIES

The assay of watermelon for its vitamin A, B, C, and G content was completed. The results showed watermelon to be a good source of vitamins A and C and to contain small but detectable amounts of vitamins B and G. The editorial comments of newspapers and magazines following a preliminary report in the form of a press release gave evidence of widespread interest in the fact that watermelon might be eaten for the vitamins it supplied. A full report was published later in a scientific journal.

The study on the vitamin A, B, and C content of spinach of three varieties was completed. The data obtained showed the three varieties to be about equally good as sources of vitamins A and B, the latter following the old terminology. The variety with compact, highly wrinkled, dark-green leaves growing close to the ground was less potent in vitamin C. This variety also lost more vitamin C during canning, than did the other two varieties. There was the same loss of both vitamins A and B in the canned product from all three varieties. A report of these studies was given at the spring meeting of the American Chemical Society, and is now being prepared for publication.

The study on the vitamin A content of olives was extended to include green as well as a second variety of ripe olives. One variety of ripe olives proved to be a very good source of vitamin A, whereas the second variety, although having a higher oil content, was a poorer source of this factor.

The methodology studies on vitamin B and vitamin G were continued, and a tentative method for the determination of vitamin G was reported at the spring meeting of the American Chemical Society. The work on these methods is complicated by evidence indicating that the basal diet has other deficiencies, the exact nature of which is as yet unknown.

Incidental to these studies the vitamin B, C, and G content of a commercial banana powder was determined. It was found that this powder was equal, weight for weight, to fresh bananas in anti-neuritic content, that it contained very little vitamin C, and that it had only one-sixth the vitamin G content of the fresh banana.

A study is well under way on the vitamin content of grapes of several varieties and the commercial grape-juice products made from some of these.

The pellagra study in South Carolina was completed, and the data obtained are being analyzed. The analyses of the data so far made indicate that the diets of the families studied are low in calcium, iron, protein, vitamins A, B, and C, as well as deficient in vitamin G. The protein supplied is not only too little, but of poor quality, especially for growing children. It is essential for reasons of health as well as economic prosperity that the diets of these people be made more adequate. This can only be done by making it possible for them to have gardens as well as milk cows. Studies on the vitamin G content of a number of foods used in South Carolina are being planned in order to get information necessary for a complete analysis of the diets used. The results from these studies show that restricted diets can be made to include sufficient vitamin G through intelligent choice of food materials without much increase in cost.

FOOD UTILIZATION AND PRESERVATION

MEAT

The work on the palatability of meat handled in cooperation with the Bureau of Animal Industry has continued. During the year 800 roasts of the following kinds from 17 States were cooked: Beef, 116; lamb, 517; mutton, 12; and pork, 155. Cooking losses and data on palatability are being correlated with production factors and the results prepared for publication.

Research on cooking methods has been continued for the purpose of determining the comparative effects of slow and rapid roasting on beef ribs and leg of lamb. So far there appears to be no definite relation between roasting temperature and the tenderness and flavor of beef and lamb roasts. There is, however, a close relation between cooking loss, or shrinkage, and oven temperature. If after beef ribs have been seared in a hot oven, the temperature is rapidly reduced so as to finish the cooking very slowly, the shrinkage of the meat when rare is about one-eighth of the fresh weight; whereas if the roasting goes on to the end in a hot oven the shrinkage is about one-fourth of the fresh weight. Well-done beef shrinks more than rare beef, other things being equal. The beef and lamb used for the cooking experiments have covered a wide range of quality as indicated by market grade. Well-finished, high-grade beef and lamb lose more fat and less water than very thin meat of the same kind and cut. Information on the character as well as the amount of cooking loss to be expected from the different kinds and cuts is necessary for estimating the food value of cooked meats. While the data accumulated so far are too limited for general application, they give a rough indication of what shrinkage can reasonably be expected when a piece of meat of a certain market grade is cooked in a definite way.

VEGETABLES AND CEREALS

During the past year the first quality tests on vegetable foods were started in cooperation with the Bureau of Plant Industry. Sixty-five seedling potatoes bred by the Bureau of Plant Industry have been studied and selections made of the most promising as determined by cooking tests. A technic was worked out for cooking these potatoes by baking, boiling, steaming, and frying in deep fat, so as to find any differences in quality brought out by the different methods of cooking, and a score card which can be used in recording tests in terms of quality was prepared.

In addition, the influence of 24 different fertilizer ratios and 5 different storage conditions upon cooking qualities of 2 varieties of potatoes was studied. The most interesting result was that storage conditions affect the cooking quality very materially, due to the accumulation of sugar in potatoes held at low temperatures. This sugar browns rapidly when the potatoes are fried, and it was therefore impossible to make good potato chips from potatoes stored at temperatures of 50° F. and below. This point is of practical significance to restaurant keepers, manufacturers of potato chips, and those engaged in handling potatoes for either of these groups.

The work on rice has been continued. Special emphasis was placed last fall on a comparative study of the native-grown and imported Patna in canned soup. Since the varieties sent in had not been seasoned as well as the imported varieties, it seemed wise to repeat these tests after a year of aging. A number of recipes have been prepared and some additional tests have been made of the amount of water absorbed during cooking by rices of different varieties. The variety and the age of the rice make a difference, but we have been unable to get a sufficient number of samples of known history to test this matter satisfactorily. One point of practical significance brought out was that certain varieties should not be shipped to countries of high altitude because they do not cook there so readily. Other varieties are available that will cook much more readily under these conditions.

In connection with our recommendation for the use of rice polishings and wheat germ in certain home products, methods for processing and keeping these in the home have been tested. These products not only tend to grow rancid if kept in the home, but become infested with insects.

The food-utilization section has prepared recipes for radio talks, special attention having been paid to development of recipes for cooking vegetables and directions for jelly making. This unit has done considerable cooking for the various exhibits where wax models must be made and also for photographing. Recipes for the use of domestic rabbit were prepared for a leaflet. The experiments to test the keeping quality of certain varieties of pickles have been checked. A special study has been made as to the length of time fruit and sugar mixtures may be kept in household refrigerators.

HOME CANNING

So many requests for information about oven canning came in that tests were made to find the temperature curve in this process. It was found that the temperature on the inside of the jar never reached higher than boiling and that heating-up tended to be somewhat slower in the oven than when the jars were immersed in boiling water. The directions sent out by the different authorities recommending the oven method vary, and even such practices as the use of a pan in which to stand the jars may cause differences in the time required for the interior of the jars to reach boiling temperature. All these factors are important in efficient sterilization, but most important is the fact that the contents of the jars, even though the jars are placed in an oven at a temperature above boiling, never attain a temperature higher than boiling. Oven canning can not, therefore, be recommended as a method for sterilizing nonacid vegetables. A check has been made also of all the home-canned material which has been canned and stored in the bureau laboratories for varying periods of time.

HOUSEHOLD REFRIGERATION

In connection with the work of the foods and nutrition division certain studies have been undertaken in household refrigeration, in order to discover the best method for handling the temporary storage of food in the home. During the past two years extensive studies

have been made of various grades of household refrigerators, with particular emphasis upon the reliability of test methods. Data from this work were used as a basis of a test code for ice-cooled household refrigerators by one of the subcommittees of specifications for refrigerators of the American Standards Association. Two papers based on these data have been published in refrigeration journals.

This work has been followed up with a more specific inquiry of the characteristics and properties of the organisms responsible for spoilage under improper refrigeration conditions in the home. The practical objective of this study is to find an answer to the questions, "When is meat spoiled?" and "Are the bacteria or the products of bacterial metabolism responsible for spoilage and consequent food poisoning?" In this respect the demonstrated ability of the predominating type of organism to break down the proteins into amino acids and to attack further and break down the amino acids has an important significance.

ECONOMIC STUDIES

STANDARDS AND COST OF LIVING

The studies of standards and cost of living previously undertaken include three groups of families—farm families, families of business and professional men living in cities, and families receiving mothers' pensions. These studies are now completed and reports have been prepared covering the food and clothing expenditures of the farm group and all items in the family budget for the two latter groups. A report of the study comparing the survey and account-book methods of obtaining data on family expenditures has also been prepared.

A new study was started during the year with a fourth group of families—those living in the southern Appalachian highlands in Kentucky. Any attempt to improve the standards of living in this region must take into consideration not only the diet, health, and living conditions of the families, but also the size and sources of the family income, the use which is made of the land, and the character of the schools, public-health agencies, and other facilities provided by the community. The study is therefore being made in cooperation with the economists and sociologists of the Bureau of Agricultural Economics and of the Kentucky Agricultural Experiment Station, and has for its general object the development of a sound economic, social, and educational program of readjustment for these families. The bureau's share in the study covers the various aspects of family living, and a special schedule has been prepared for securing information which will reveal the most promising points for improving diet and living conditions and increasing the efficiency with which the money and labor resources of the family are used.

In response to the demand for information concerning studies of standards and cost of living an annotated bibliography of over 200 titles has been prepared covering all the important studies that have been made in the United States. This bibliography was presented at the Pan-Pacific Women's Conference held in Hawaii during the summer of 1930 and will be utilized by investigators in the Pan-Pacific countries who are planning to initiate standard-of-living studies and wish to become familiar with the scope and methods used in similar investigations in the United States.

DIETARY STUDIES

Up to the present time studies of food-consumption habits have been made with eight different population groups. Three of these investigations have formed part of the larger studies of family standards of living referred to above, and reports of these have been prepared. The other five studies have dealt with food consumption only. During the year reports appeared on two of these studies, one a circular on the nutritive value and cost of food served to college students and the other a pamphlet on a study of the food at St. Paul's School.

The last study undertaken of the dietary habits of farm families in South Carolina affected with pellagra has been continued during the year in cooperation with the foods and nutrition division.

HOUSEHOLD PRODUCTION

The study of the use of time by home makers has been extended during the year to include city households in order that comparison may be made between rural and urban conditions. Records have been obtained from over 500 college graduates who are married and living in cities of 50,000 population and over. These home makers, representing as they do a fairly uniform and relatively favored group as to economic and social status, afford a significant contrast with the larger group of rural home makers previously studied. The report of the rural group is being prepared and the analysis is now being started of the city records.

The results of these studies indicate the extent to which home makers are overworked and underworked in various types of homes and at various periods in the family's life, and the extent to which labor-saving equipment and the use of commercial products and services reduce the time required for housekeeping. Since the records kept by the home makers cover all of their activities during the 24 hours of each day the results also throw light on the amount of leisure which they enjoy and the ways in which they use this leisure. This information will be of value to extension workers and other groups interested in aiding the home maker to reduce the work of housekeeping and to coordinate other work and interests with her home-making responsibilities.

TEXTILES AND CLOTHING

The introduction of new fibers and finishes into the textile market has brought increasing problems to the home maker who, with a limited knowledge of textile values and no facilities for quickly testing materials, is trying to make wise selections from the materials shown on the retail counter. Realizing the seriousness of the situation from an economic standpoint, the Division of Textiles and Clothing has attempted to assist by pointing out the need of certain fundamental researches which would give facts helpful to the consumer and by initiating as many of such projects as possible. Cooperation has been effected with the American Home Economics Association in the efforts of that organization to set up quality specifications which can be used by the home maker in purchasing certain textile commodities. An outline of club programs considering the

various aspects of household purchasing has been prepared in cooperation with the association, and has been very widely used this year by women's groups throughout the country.

WOOL UTILIZATION

For the first time since the organization of the division, it has been possible to start projects dealing directly with wool utilization. A small appropriation made for this purpose has provided for the installation of a constant humidity room and much of the equipment necessary for future work along this line.

A series of investigations is under way in cooperation with the Bureau of Animal Industry in which the effect of various grades of new and reworked wool on the physical properties of blankets is studied. Wool produced under the direction of the Bureau of Animal Industry is being used, and the manufacturing processes are carried on under controlled conditions. Arrangements have been made to test the wearing qualities of the blankets in a Boston hospital and a United States veterans' hospital in Washington. Laboratory determinations of the physical properties of the finished fabrics will be made, and in this connection methods of making special tests have been investigated. An optical method of determining the thickness of napped fabrics has been developed, and special apparatus of various kinds built.

COTTON UTILIZATION

Studies on the relation of grade and character of cotton to the properties and wearing qualities of finished fabrics have been continued. Cotton graded by specialists in the Bureau of Agricultural Economics was made into sheets under controlled, experimental conditions. These were completely analyzed in the laboratories of the bureau and 109 sheets are being used under actual wearing conditions in a Washington hotel. A worker checks the condition of these sheets each day and at definite intervals removes samples for laboratory testing.

Special attention is being given to the utilization of cotton for household purposes. Cooperation has been continued with the new uses committee, upon which the Department of Commerce and the Cotton Textile Institute, as well as the Department of Agriculture, have representation. The farmers' bulletin on window curtaining has been revised and is now in press, and a series of leaflets on household furnishings utilizing textile materials is in course of preparation.

Investigations on the deterioration of cotton materials during laundering have been continued. Special attention has been given to a study of the formation of oxidized cellulose as a result of temperatures used in ironing. The quantitative determination of relative amounts of this material was one of the first problems. The following methods were used for this purpose: Viscosity of cuprammonium solutions of cotton, alkali solubility, silver number, and macro and micro copper numbers.

The viscosity measurements were made with a burette consistometer. By means of this instrument a series of accurate observations were rapidly obtained at different rates of flow by permit-

ting the hydrostatic head to vary. The results are plotted in flow-pressure diagrams. Viscosity measurements of cotton solutions have previously been made at a single average hydrostatic head.

The method commonly used for determining the alkali solubility of tendered cotton was found to give high and variable results. Accurate values were obtained by preventing the adsorption of water vapor during weighing and by determining the percentage of moisture originally present in the fabric on a separate sample. Glass-sintered filter crucibles proved much more satisfactory than the Gooch crucibles generally used.

Copper numbers were found to be influenced slightly by the degree of subdivision of the sample of fabric taken for analysis. In order to obtain a relatively uniform degree of subdivision and to prepare samples easily and rapidly, a special nonheating electric mill with a cutting rather than a tearing or grinding action was chosen for disintegrating the fabric. The values varied considerably with the concentration of the alkali solution used and also with the temperature of digestion. A distinct end point was obtained in the titration by substituting sodium molybdate for ferric alum.

Results obtained for copper numbers by the micro method agreed with those found by the macro method. The structure of cloth often appears somewhat uneven over the surface. Under such conditions the micro copper number will be particularly useful in testing small scorched areas.

Preliminary experiments indicate that the amount of oxidized cellulose formed as estimated by these methods is proportional to the color of scorch obtained under similar experimental conditions. The amount of size present in the fabric appears to influence the results.

Colorimetric methods of estimating the amount of scorch were studied. It was found that slight degrees of scorch were not always detectable by total color measurements. However, with the use of a modified spectro-photometric method it was possible to detect the very lightest scorch in cloth by the changed reflection for light in the violet part of the spectrum as given by the mercury lamp. Very slight surface scorch was thus found on the thicker sheetings for which tensile-strength tests appeared to be unchanged.

Various changes have been made in the experimental ironer. In order to obtain the needed higher temperatures, it was necessary to construct a new heating element of higher wattage and different heat distribution along the length of the shoe. Owing to the warping effect obtained in the metal of the shoe on being heated to higher temperatures, a more detailed study of the contact between the heated shoe and the roll of the ironer is being made. Different improvements in the padding of the roll are also being tried out.

Methods for obtaining a uniform moisture distribution in cloth to be ironed have been considered and a quick laboratory method for determining the amount of the moisture in the cloth has been selected.

The finishing of cotton fabrics in the laundering process has opened up important fundamental problems in regard to the relation of viscosity of starch mixtures to the penetration of such mixtures into yarns and fabrics and to the stiffness of the laundered fabrics. Rice, corn, potato, wheat, dasheen, and canna starches are

being used in this work with the object of determining the particular type of starch mixture most useful for cotton-fabric sizing. Viscosity determinations have been made of the pastes at the temperature used in starching and their penetration into yarns and fabrics studied by microphotographic technic developed for this research. The size of the original and of the swollen starch grains has been measured in an effort to explain some of the differences in penetration which have been noted. It appears that dasheen, rice, and corn starch grains which have the smallest raw and swollen sizes penetrate most thoroughly. Wheat, which is not uniform in size, seems both to penetrate and to coat the yarns and fabrics. The large grain starches—potato and canna—form heavy coatings of paste and penetrate only slightly.

CHILDREN'S CLOTHING

The work on children's clothing has continued to meet a widespread demand. To date 325,000 copies of the leaflets prepared in the division describing self-help clothing have been distributed, most of them in answer to individual requests. Two exhibits of the garments have been in constant demand and have been sent to 25 child clinics, nursery schools, and extension conferences. At some of these they are retained as long as six weeks, in order to accommodate many different conferences and group meetings. These included college and nursery school classes, conferences of extension leaders, and meetings of rural and urban home makers. The reports indicate that at least 10,000 women were reached in this way. A number of the State extension offices have made duplicate sets of the garments sent from Washington and are using them in their extension classes.

Leaflet 54, Play Suits for Winter, Leaflet 52, Suits for the Small Boy, and Leaflet 63, Ensembles for Sunny Days, came from the press during the year. The leaflets on children's rompers and dresses for the little girl are being revised. The designs developed by the division are attracting the attention of pattern and garment manufacturers and are being introduced more and more into the trade. To date commercial patterns are being made for 11 of the self-help garments designed in this division.

A study of the physical properties of 25 cotton and wool fabrics available for children's play suits was completed and submitted for publication. Fourteen different physical and mechanical tests were made on each of these in an effort to form an estimate of their comparative value for this purpose. A lightweight duck and a new unclassified cotton cloth (both made from 2-ply yarns) were found to be the strongest and the most durable of the cotton materials. One of the woolen coverts proved to be particularly resistant to wear and to tearing. The close, proofed fabrics, such as sail cloth, duck, and the unclassified cotton fabrics, were especially impervious to the passage of air. Since in the measurements for heat-retaining power, an unusually high value was given by a lightweight, porous, fluffy woolen material under one of the close cotton fabrics, such a combination was recommended for use in extremely cold weather. The results of the study were printed in a trade journal for the information of manufacturers. In connection with this project, an apparatus for determining the waterproof properties of fabrics was developed and a paper describing it published in a scientific journal.

HYGIENE OF CLOTHING

A summary of all books and periodical references dealing with the relation of clothing to health was printed during the year in order to show the importance of this subject and the great dearth of information in regard to it. A complete search of all English, French, and German publications on this and related subjects revealed only approximately a thousand references and most of these represented opinions and not facts.

GARMENT SIZES

The matter of correct garment sizes was again brought to the attention of the division this year. Requests have come for assistance from garment, glove, and shoe manufacturers who recognize that the present chaotic situation can not be remedied without a comprehensive determination of the body measurements necessary for clothing. Preliminary to research on this subject a summary of the literature was made and published as *An Annotated List of Literature References on Garment Sizes and Body Measurements*.

TEXTILE BIBLIOGRAPHICAL SERVICE

In response to a resolution passed by the Textile Research Conference called by the American Home Economics Association at Manhattan, Kans., last winter, the division has increased its literature reference service. The literature dealing with textile research is at present meager and widely scattered. By providing reference lists, abstracts, and bibliographies, assistance is given the many investigators who do not have access to well-equipped libraries. An annotated list of periodicals recommended for those schools contemplating research in any phase of textiles has been prepared.

LIBRARY

With the growth of the bureau the library has increased its book collection to about 2,700 volumes in addition to State and Government publications. The bureau librarian has assisted in the revision of special bibliographies, and has added materially to the efficiency of the work of the bureau by the help that she gives in assembling material needed by members of the research staff. Gradually this bibliographical assistance is being extended to research workers in the States when their library facilities are not available.

INFORMATION SERVICE

That the research program of the bureau is meeting a definite need on the part of the general public as well as of specialized groups of producers and professional workers is clearly evidenced by the yearly increasing demands on the information section. During the past year 20,000 letters requesting information on some phase of home economics were answered, an increase of 5,000 over the preceding year and just double the volume handled two years ago. The distribution of our printed publications also reached a new total of 2,925,882 copies sent free in response to definite requests and not including sales by the Superintendent of Documents.

The following 14 publications have been issued through department channels during the past fiscal year, or are in press:

Vitamins in Food Materials. Circular 84.

Nutritive Value and Cost of Food Served to College Students. Circular 89.

Bibliography on the Relation of Clothing to Health. Miscellaneous Publication 62.

An Annotated List of Literature References on Garment Sizes and Body Measurements. Miscellaneous Publication 78.

Window Curtaining. Farmers' Bulletin 1633. (In press.)

Pork in Preferred Ways. Leaflet 45.

Reindeer Recipes. Leaflet 48.

Ice Creams Frozen without Stirring. Leaflet 49.

Suits for the Small Boy. Leaflet 52.

Play Suits for Winter. Leaflet 54.

Ensembles for Sunny Days. Leaflet 63.

Rabbit Recipes. Leaflet 66. (In press.)

Nutrition Charts. Series of nine; 16 by 20 inches in size.

Household Refrigeration Charts. Series of six; 16 by 20 inches in size.

Eight articles were also contributed to the Yearbook of Agriculture, 1930, describing as many different phases of the work in economic problems, food and textile utilization, vitamin research, and household refrigeration. Press material and special articles for scientific, trade, and educational journals reached a total of 309 items. The majority of these popular and technical articles were illustrated with photographs taken especially for the purpose. The posing of photographs in line with modern graphic developments to illustrate particularly the press material on food preparation has become one of the important functions of the information service. Writers for magazines and of feature articles for newspapers are requesting more and more material of this kind to accompany subject matter that they get from the bureau. Material supplied in this way greatly augments that written within the bureau, and every effort has been made to meet these requests from outside writers.

The cooperative arrangement with the radio service whereby material is furnished regularly for the housekeepers' chats was continued. This year 150 menus were supplied, oftentimes with accompanying new recipes and subject matter suggestions for inclusion in the radio releases. In addition 45 radio talks known as the Household Calendar, forming part of the Farm and Home Hour, have been broadcast direct from Washington over a chain covering the United States as far west as the Rocky Mountains. The letters from approximately 10,000 women a month received by the radio service are conclusive proof that this service is what women want and is one of the most successful ways yet tried for disseminating information from the department.

An exhibit of wax models featuring beef, the center of a balanced meal, was prepared for the 1929 International Livestock Show in Chicago, and similar models of poultry were sent to the International Poultry Congress in London.

In every line of its work, the information service reflected the steadily growing demand of home makers, teachers, and all groups concerned with the production and consumption of the goods and services used in the home, for scientific facts gathered from the home-economics standpoint.

REPORT OF THE DIRECTOR OF INFORMATION

UNITED STATES DEPARTMENT OF AGRICULTURE,
OFFICE OF INFORMATION,
Washington, D. C., August 31, 1930.

SIR: I present herewith a report on the information work of the department for the fiscal year ended June 30.

M. S. EISENHOWER, *Director of Information.*

Hon. ARTHUR M. HYDE,
Secretary of Agriculture.

SCOPE OF WORK

By distributing approximately 25,000,000 popular and technical publications and over 10,000,000 lists of farmers' bulletins and leaflets, by giving to the press of the country more than 3,000 news and interpretive articles, by furnishing speakers or manuscripts daily to over 300 radio stations in all parts of the country, by cooperating with special writers, correspondents, and others, by having representatives make personal addresses, by answering several million letters, supplying lecturers to colleges and universities, and reaching farmers direct through the Extension Service,¹ the Department of Agriculture made its information available to the public during the fiscal year 1930. Other calls for information were cared for by the issuance of over 58,000,000 pages of mimeographed, multigraphed, or rotaprinted material by the Office of Information and a large volume of similar material by the bureaus of the department.

To reflect the manifold activities of such a large organization is in itself a task. To do this in a way that will lead to the adoption of improved farm and home practices by millions of widely scattered people, and to the promotion of necessary cooperation of numerous organizations with the department, calls for the utmost in coordination and organization. Publications, press, and radio are three correlated and effective media used to interpret the results of the scientific investigations and the service and regulatory work of the department to the public.

COOPERATIVE EFFORT IN INFORMATION WORK

During the fiscal year 1930 scientists and administrators in all branches of the department showed a growing tendency to devote more time to disseminating information. The task can not be con-

¹ See Report of the Director of Extension Work for 1930.

fined to a small staff or office. Rather it requires the constant cooperation of every person working for the advancement of agriculture. Unity of effort on the part of officials and especially of the several information staffs enabled the department to handle the informational aspects of the extraordinary developments in agriculture and in Federal help to agriculture that occurred during the year. These emergency situations were, of course, dealt with in addition to the regular task of aiding daily in removing the disparity that exists between agricultural knowledge possessed by the best informed and the average practices on American farms.

ASSISTING THE FEDERAL FARM BOARD

The organization of the Federal Farm Board to aid in the relief of agricultural distress by stimulating and strengthening cooperation among farmers called for new information activities by the department. Associated with the problems of cooperation were those of surplus agricultural products and the curtailment of production, the stimulation of a safe farming program for the South, the widening of the spread of market news and the use by farmers of economic information in general, and a host of other developments that demanded emergency work on the part of information specialists.

Even though the Federal Farm Board set up an information office of its own, the work of the board required much greater informational activity on the part of the department. Both the public and the board look to the department for fundamental data on agriculture. The bureaus of the department, in addition to mobilizing the facts about agriculture hitherto assembled, have had to widen their activities to marshal additional data, and the Office of Information staff was naturally charged with the responsibility of putting the assembled facts into usable form and giving them the widest possible dissemination. The radio was used to reach vast audiences with great speed; this instrument was particularly effective in giving farmers the outlook reports, price analyses, market trends, and so on. The newspapers and magazines extended their full cooperation in aiding the department to further the educational phases of the program. The volume of publications issued was materially increased. This was particularly desirable, because no other medium of information has yet replaced the printed word in efficacy or permanence.

OTHER EMERGENCIES

The outbreak of the Mediterranean fruit fly in Florida, drought in many areas, and other emergency matters not connected with the new program developed under the agricultural marketing act, called for the closest cooperation of all department and State offices doing agricultural information work.

The unusual interest of the public in agriculture necessitated the addition to the staff of a special agricultural writer to prepare for farm journals, newspaper syndicates, and other publications interpretive articles on agriculture.

INFORMATION SURVEY

During the year four representatives of the agricultural colleges—Bristow Adams, of Cornell; J. B. Hasselman, of Michigan; John R.

Fleming, of Ohio; and F. H. Jeter, of North Carolina—reviewed the information activities of the department and made many pertinent recommendations. Their report has been placed on record permanently and is available for official perusal. Among their suggestions were these: (1) That since expenditures for printing and binding lead to the adoption of improved farm and home practices with a minimum of time and money, ample funds should be provided for the work; (2) that the budget for printing and binding should be a fixed percentage of the department budget so that periodic congestions would be avoided; (3) that a closer system of coordinating the publication work of the colleges and the department be worked out; (4) that the department increase its output of research publications; (5) that the number of series of department publications be reduced and that the average size of bulletins be decreased; (6) that the output of leaflets be increased; (7) that the press and radio material be increased in quantity.

NEW BOOK ABOUT THE DEPARTMENT

The potential usefulness of the department to all classes of people is dependent on their familiarity with the nature of the facts and services available. In order to promote public understanding of the department and to provide information for the thousands who annually inquire about the nature of its work, the Office of Information prepared and published a book called *The United States Department of Agriculture, Its Growth, Structure, and Functions*.

YEARBOOK OF AGRICULTURE

The Yearbook of Agriculture was prepared, and 400,000 copies were printed for distribution by Congress and the department. As usual the first section was the Secretary's annual report to the President, comprising discussions of outstanding developments in agriculture; the second section contained more than 300 brief, popularized accounts of what's new in agriculture; and the third section was made up of agricultural statistics. In conformity with the practice adopted by publishers of most yearbooks, the dating of the Yearbook was changed to indicate the year in which the book is printed rather than the year surveyed. The new dating more clearly indicates the up-to-date character of the contents of the book.

EDITORS' MEETING

In June, 1930, the Office of Information extended an invitation to the American Association of Agricultural College Editors to meet in Washington during August. Fifty editors from 32 States and the editors of the department attended the 4-day editorial and radio sessions. Federal-State cooperation in information work was promoted appreciably as a result.

OFFICE OF INFORMATION PERSONNEL

At the beginning of the fiscal year 1930 there were 191 employees in the Office of Information. During the year Ernest G. Moore and John R. Deatherage were appointed as agricultural writers in the press service to fill existing vacancies. Alan Dailey and Frank L. Teuton were added to the staff of agricultural writers in the radio

service. E. W. Carter was transferred from the Government Printing Office to assist in the printing section of the division of publications. The editor of the Official Record, Lurton R. Ender, was placed in charge of the information work of the Bureau of Dairy Industry, and Katharine A. Smith, editor of the Food and Drug Administration, was transferred to take over the work formerly handled by Mr. Ender. John R. Fleming, formerly assistant editor at Ohio State University, was added to the personnel of the Office of Information to prepare for leading agricultural publications special interpretive articles on agriculture, particularly on its economic phases. John S. Lucas was placed in charge of the newly organized mail and files section. Edward F. Shipp, for 12 years a photographer in the Office of Information, died June 20, 1930. The number of employees at the close of the fiscal year 1930 was 194.

EXPENDITURES

The expenditures for salaries and expenses for the Office of Information were \$4,971.98 greater than the expenditures for 1929.

Funds available for salaries and expenses-----	\$400,000.00
Salary limitation -----	375,000.00
Expenditures for salaries-----	369,789.64
Expenditures for general expenses-----	30,190.65
Total expenditures-----	399,980.29
Unexpended-----	19.71

Herewith is a brief review of the work of the division of publications, press service, and radio service of the Office of Information for the fiscal year 1930.

DIVISION OF PUBLICATIONS

The fiscal year 1930 was a particularly important one in the work done by the division of publications. Emergencies in the agricultural situation resulted in the receipt of a large number of rush manuscripts. These were handled expeditiously along with the regular manuscripts received for publication by the department, and a total of 1,702 manuscripts were sent to the printer during the year.

The publication attention of each bureau of the department was, as usual, fixed on getting out in either new, revised, or reprinted form the material most in demand by the public or most necessary in furthering its program or projects. Although many original articles are printed in outside mediums, the advantages of spreading official information through the publication channels of the department are recognized by both administrators and authors. Thus during the past year the Bureau of Chemistry and Soils increased its general bulletin and circular output 33 per cent over the preceding year and the output of technical bulletins and of articles for the Journal of Agricultural Research 400 per cent.

NEW PUBLICATIONS NEEDED

Requests for information and publications which come from the general public enable the division of publications to know what material is in demand. To attempt to correct the situation caused by the

receipt of numerous inquiries for certain agricultural information which the department does not have available in printed form, the chief of this division sent a list of such subjects to the bureaus concerned and suggested the preparation of manuscripts on those subjects for publication.

ECONOMY EMPHASIZED

The increase of \$100,000 in the printing and binding fund for the year made it possible to increase the allotments to those bureaus whose printing needs were most acute. At the same time economy in publishing was constantly emphasized. The desirable economy in publishing is the reduction in the unit cost for bulletins by eliminating unnecessary tables, illustrations, and text rather than by decreasing the volume of bulletins published; this is particularly true in view of the fact that the department is not yet in a position to publish the results of research and other work as rapidly as they should be published. A saving of approximately \$9,000 was effected during the past fiscal year, principally by changing the stock for the periodical Crops and Markets from machine-finish paper to newsprint.

NEW PERIODICAL AUTHORIZED

On January 22, 1930, authorization was granted by the Bureau of the Budget to print the Extension Service Review, a new monthly periodical issued by the Extension Service, at a cost not to exceed \$6,000 annually. Three numbers were printed in the fiscal year 1930. During the year the Bureau of the Budget also authorized an increase from \$17,700 to \$19,000 annually for printing the Experiment Station Record. The total authorization for periodicals is now \$130,400 annually. Of this amount \$122,900 is chargeable to the appropriation for printing and binding and \$7,500 to the appropriation for the construction of post roads.

RUSH WORK

As a result of splendid cooperation by the Government Printing Office, the department was able to issue promptly a number of important publications urgently needed for drought relief work, for the Mediterranean fruit-fly campaign, for the seed-loan work in the Southeastern States, and for other emergency requirements.

During the year 4,594 requisitions for printing and binding were drawn. Owing to unusual demands for emergency field printing needed in the work of suppressing the Mediterranean fruit fly, authorization to increase expenditures for such printing from \$7,500 to \$8,500 was granted by the Joint Committee on Printing, and a total of \$8,288.95 was expended, \$3,465.92 from the appropriation for printing and binding and \$4,823.03 from special funds.

DISTRIBUTION OF PUBLICATIONS

Many farmers' bulletins and leaflets available for distribution become exhausted so soon that both inconvenience and the additional expense of going back to press result. Consequently, larger editions of reprints of many of these were ordered during the year, and more attention was given to forecasting the demand for publications several months hence and having copies available when needed.

The total distribution of all publications during the fiscal year 1930 showed an increase of 9,189,959 over the distribution during the preceding year, an increase of more than 36 per cent. The largest distributions were farmers' bulletins, 13,337,040; farmers' bulletin lists, 10,272,146; and leaflets, 1,940,681. All other publications totaled 8,743,801.

In the leaflet series there was an increase of 150 per cent over the number of copies in this series distributed the year previous. The increase in the number of farmers' bulletins distributed was 2,040,573, and the total distribution of these popular bulletins was the largest since 1922. A great part of this increase occurred through congressional channels, this increase amounting to nearly 36 per cent over the distribution during the previous fiscal year. More than 500,000 individual requests for publications were received from Members of Congress.

Statistics about publications and the work of this division are given in Tables 1, 2, and 3, and in the tabulations which follow.

Despite the large distribution of publications, the department was able to supply only 60 per cent of the bulletins requested by farmers. For several months more than 100 farmers' bulletins were not available for distribution.

During the year the much-needed work of revising the Style Manual of the Government Printing Office was undertaken. F. D. Smith was appointed to serve as the department's representative on the general committee which has this matter in hand. Considerable progress was made up to the close of the year.

INDEXES AND BIBLIOGRAPHIES

An interesting trend during the year was the increased attention given by the bureaus to the publication of bibliographies, indexes, handbooks, and other material of a reference nature. As the work of the department and other agricultural agencies has grown and the printed material giving the results of the work has increased, it has become more and more necessary to have publications available giving this type of information.

The following indexes were prepared during the year: Index to Farmers' Bulletins 1001-1500, index to volume 8 of the Official Record, indexes to volumes 38 and 39 of the Journal of Agricultural Research, index to the 1930 Yearbook. Title pages and tables of contents were issued for the following: Department Bulletins 1476-1500, Farmers' Bulletins 1551-1575, Farmers' Bulletins 1576-1600, Technical Bulletins 76-100, Technical Bulletins 101-125, Technical Bulletins 126-150. Title pages and tables of contents for the following were prepared and made ready for the printer: Farmers' Bulletins 1601-1625, Technical Bulletins 151-175.

The cards for the 25-year index of all department publications were in the final stage of preparation for the printer at the close of the year. The following series of publications issued prior to January 1, 1930, were indexed: Circulars, department bulletins, soil surveys, and technical bulletins.

STATISTICS

TABLE 1.—Estimated expenditures and obligations for printing and binding, 1930

Item	Expended and obligated	Printed copies	Item	Expended and obligated	Printed copies
	<i>Dollars</i>	<i>Number</i>		<i>Dollars</i>	<i>Number</i>
Agricultural Situation.....	2,717.07	127,000	Leaflets, new.....	4,163.00	595,000
Annual reports.....	10,740.39	43,100	Leaflets, reprints.....	8,532.71	1,763,829
Binding.....	33,052.97	14,970	Letterheads.....	8,727.00	4,834,500
Circulars.....	23,613.17	489,349	Miscellaneous publica-		
Climatological Data.....	1,762.83	4,400	tions.....	29,199.51	717,646
Clip Sheet.....	3,749.72	295,800	Monthly List of Publica-		
Congressional documents.....	2,876.00	6,890	tions.....	1,203.47	351,000
Crops and Markets.....	57,565.58	1,678,500	North American Fauna.....	1,812.82	3,000
Emergency field printing.....	3,695.39		Official Record.....	10,848.97	869,700
Experiment Station bul-			Posters.....	9,125.34	208,500
letins and reports.....	4,457.42	43,046	Reprints of former series	6,735.46	789,104
Experiment Station			Service and Regulatory		
Record.....	18,584.59	144,408	Announcements.....	11,387.53	709,450
Extension Service Review.....	1,345.76	30,000	Soil surveys.....	113,688.77	130,000
Farmers' bulletins, new.....	20,097.85	1,045,000	Statistical bulletins.....	13,495.73	23,000
Farmers' bulletins, re-			Technical bulletins.....	63,676.62	545,388
prints.....	185,609.09	14,019,390	Unnumbered publica-		
Farmers' bulletin lists.....	13,450.65	11,550,000	tions and reports.....	24,238.37	370,900
Forest Service recrea-			Monthly Weather Review.....	9,825.10	19,825
tion folders.....	12,712.64	1,176,700	Monthly Weather Review		
Forest Worker.....	1,643.30	6,000	separates.....	613.91	12,550
Indexes.....	1,386.17	31,850	Yearbook.....	28,000.00	20,000
Inventory of Seeds and			Yearbook separates.....	2,762.66	146,900
Plants Imported.....	2,248.30	7,650			
Job work.....	190,727.25	90,106,387	Total.....	1965,542.72	2133,129,589
Journal of Agricultural					
Research.....	6,308.15	47,940			
Journal of Agricultural					
Research separates.....	19,161.46	150,917			

¹ Appropriation.....\$842,000.00
Overobligated and transferred to 1931 account.....123,542.72
² Exclusive of number of copies printed under "Emergency field printing."

TABLE 2.—New manuscripts (including revisions of publications requiring new titles and numbers) for department publications handled July 1, 1929, to June 30, 1930

Item	Manu- scripts on hand July 1, 1929	Received	Disap- proved	Sent to Govern- ment Printing Office	With- drawn	On hand June 30, 1930
Agricultural Situation.....		12		12		
Annual reports.....		18		18		
Atlas of American Agriculture.....						
Circulars:						
New.....	5	46		40		11
Reprints and revisions.....		18		18		
Climatological Data.....		10		10		
Section summary.....		13		13		
Clip Sheet.....		52		52		
Crops and Markets.....		12		12		
Department bulletins, reprints and revi-						
sions.....		35		35		
Department circulars, reprints and revi-						
sions.....		14		14		
Experiment Station bulletins and reports:						
New.....		12		10		2
Reprints and revisions.....						
Experiment Station Record.....		22		20		2
Extension Service Review.....		3		3		
Farmers' bulletins:						
New.....	10	28		22	2	14
Reprints and revisions.....		528		528		
Farmers' bulletin lists.....		8		8		
Forest Service recreational folders:						
New.....		37		37		
Reprints and revisions.....		5		5		
Forest Worker.....		6		6		

TABLE 2.—*New manuscripts (including revisions of publications requiring new titles and numbers) for department publications handled July 1, 1929, to June 30, 1930—Continued*

Item	Manu- scripts on hand July 1, 1929	Received	Disap- proved	Sent to Govern- ment Printing Office	With- drawn	On hand June 30, 1930
Indexes.....		14		14		
Inventories.....		5		5		
Journal of Agricultural Research.....		24		24		
Journal of Agricultural Research separates.....	58	131	24	124	3	38
Leaflets:						
New.....	3	22	1	17		7
Reprints and revisions.....		51		51		
Miscellaneous circulars:						
New.....		2	1		1	
Reprints and revisions.....		8		8		
Miscellaneous publications:						
New.....		34		27		7
Reprints and revisions.....		4		4		
Monthly List of Publications.....		11		11		
Monthly Weather Review.....		13		13		
Monthly Weather Review separates.....		10		10		
Monthly Weather Review Supplement.....		23		23		
North American Fauna.....						
Official Record.....		52		52		
Posters.....		13		13		
Public Roads.....		12		12		
Service and Regulatory Announcements (including Notices of Judgment, Notices of Quarantine, Bureau of Animal In- dustry Orders).....		180		180		
Snow and Ice Bulletin.....		15		15		
Soil surveys.....		56		54		2
Statistical bulletins:						
New.....		5		4	1	
Reprints and revisions.....						
Technical bulletins:						
New.....	17	62		56	4	19
Reprints and revisions.....		21		21		
Unnumbered publications and reports.....	1	20		21		
Weekly Weather and Crop Bulletin.....		52		52		
Yearbook.....		1		1		
Yearbook separates.....		27		27		
Total.....	94	1,747	26	1,702	11	102

¹ One index.TABLE 3.—*Summary of publications received and distributed by the Department of Agriculture from July 1, 1929, to June 30, 1930*

Item	On hand July 1, 1929	New	Reprints	Available for distri- bution	Distrib- uted	On hand June 30, 1930
Agricultural Situation.....		127,000		127,000	127,000	
Annual reports.....	29,628	42,100	1,000	72,728	53,058	19,670
Atlas of American Agriculture.....	5,778			5,778	630	5,148
Circulars.....	175,865	399,232	98,500	673,597	390,450	283,147
Climatological Data.....		5,100		5,100	5,100	
Climatological Data (Section Sum- mary).....		7,200		7,200	7,200	
Clip Sheet.....		295,000		295,000	295,000	
Crops and Markets.....		1,674,000	3,000	1,677,000	1,677,000	
Department bulletins.....	485,925	48,000	126,700	660,625	271,227	389,398
Department circulars.....	358,559		87,300	445,859	222,461	223,398
Experiment Station bulletins and reports.....	10,645	48,700		59,345	55,535	3,810
Experiment Station Record.....	10,139	129,600		139,739	125,027	14,712
Farmers' bulletins.....	6,085,686	1,651,924	14,012,189	21,749,799	13,337,040	8,412,759
Farmers' bulletin lists.....		11,766,596		11,766,596	10,272,146	1,494,450
Forest Service recreational folders.....	6,115	372,900	145,000	524,015	436,115	87,900
Forest Worker.....		6,000		6,000	6,000	
Indexes.....	21,142	57,300		78,442	53,627	24,815
Inventories of Seeds and Plants Im- ported.....	5,664	15,800		21,464	21,464	
Journal of Agricultural Research.....	21,962	48,000		69,962	48,722	21,240

TABLE 3.—*Summary of publications received and distributed by the Department of Agriculture from July 1, 1929, to June 30, 1930—Continued*

Item	On hand July 1, 1929	New	Reprints	Available for distri- bution	Distrib- uted	On hand June 30, 1930
Journal of Agricultural Research separates.	221, 907	159, 700	200	381, 807	156, 897	224, 910
Leaflets.....	660, 757	605, 000	1, 739, 000	3, 004, 757	1, 940, 681	1, 064, 076
Miscellaneous circulars.....	341, 620	200	215, 000	556, 820	240, 881	315, 939
Miscellaneous publications.....	187, 624	575, 274	105, 472	868, 370	609, 020	259, 350
Monthly List of Publications.....		381, 400		381, 400	381, 400	
Monthly Weather Review.....		21, 350		21, 350	21, 350	
Monthly Weather Review separates.....		12, 450		12, 450	12, 450	
North American Fauna.....	2, 996	3, 000		5, 996	3, 075	2, 921
Official Record.....		869, 800		869, 800	869, 800	
Posters.....	368, 450	124, 500	45, 000	537, 950	169, 871	368, 079
Public Roads.....	7, 012	63, 000		70, 012	52, 524	17, 488
Service and Regulatory Announce- ments.	491, 834	515, 471	163, 500	1, 170, 805	605, 877	564, 928
Snow and Ice Bulletin.....		24, 000		24, 000	24, 000	
Soil surveys.....	100, 871	98, 000	8, 000	206, 871	50, 052	156, 819
Statistical bulletins.....	38, 645	18, 000		56, 645	16, 892	39, 753
Technical bulletins.....	165, 237	408, 000	59, 000	632, 237	398, 164	234, 073
Unnumbered publications.....	544, 628	664, 780	915, 500	2, 124, 908	968, 452	1, 156, 456
Weekly Weather and Crop Bulletin.....		234, 000		234, 000	234, 000	
Yearbook.....	17, 959	20, 000		37, 959	23, 021	14, 938
Yearbook separates.....	121, 610	86, 000	31, 500	239, 110	110, 459	128, 651
Total.....	10, 488, 258	21, 578, 377	17, 755, 861	49, 822, 496	34, 293, 668	15, 528, 828

SEGREGATION SHOWING DISTRIBUTION OF FARMERS' BULLETINS FROM JULY 1, 1929,
TO JUNE 30, 1930

Distributed by Congress.....	9, 729, 022
Schemes for new bulletins.....	112, 500
Orders from bureaus in the department.....	690, 341
Extension Service orders.....	1, 507, 906
Miscellaneous orders.....	1, 297, 271
Total.....	13, 337, 040

CONGRESSIONAL DISTRIBUTION

Farmers' bulletins.....	9, 729, 022
Leaflets.....	828, 308
Cookbooks.....	102, 260
Various other publications charged to Congress.....	98, 185

10, 757, 775

Farmers' Bulletin List No. 1.....	9, 005, 550
Farmers' Bulletin List No. 3.....	1, 266, 596

10, 272, 146

OTHER DISTRIBUTION DATA

Communications received.....	1, 055, 112
Communications referred to other bureaus.....	54, 180
Communications referred to other departments.....	8, 287
Orders made on Superintendent of Documents.....	530, 314
Postal-card forms addressed and mailed.....	66, 098
Franks addressed.....	26, 933
Letters dictated and written.....	27, 130
Index cards written.....	9, 400
Form letters addressed and mailed.....	2, 966
Letters containing remittances received and handled.....	17, 948
Amount of remittances.....	\$5, 289. 26
Visitors requesting publications.....	3, 745
Publications given to visitors.....	42, 380

Telephone calls (requests for publications).....	6, 161
Congressional documents received and distributed.....	73, 180
Foreign mail orders.....	5, 322
Publications mailed to foreign addresses.....	311, 259
Cost of postage for foreign mail.....	\$5, 874. 96
Schemes of distribution for new publications.....	420
New addresses on mailing lists.....	2, 339
Addresses discontinued on mailing lists.....	9, 698

DRAFTING WORK

Drawings.....	93
Graphs and charts.....	428
Maps.....	63
Lettering.....	475
Retouching.....	183
Layouts.....	409
Air brush.....	48
Cover pages.....	59
Posters.....	14
Placards.....	2
Miscellaneous.....	176
Engrossing.....	28
Total.....	1, 978

PHOTOGRAPHIC WORK

Photographic prints.....	100, 263
Negatives.....	15, 478
Negatives developed.....	2, 771
Rotaprint plates.....	1, 000
Lantern slides.....	13, 323
Lantern slides bound.....	9, 099
Lantern slides colored.....	1, 469
Bromide enlargements.....	3, 725
Bromides mounted.....	3, 226
Bromides colored.....	89
Solar bromides.....	1, 628
Prints dry mounted.....	3, 752
Transparencies.....	195
Transparencies colored.....	17
Photostats.....	17, 199
Total.....	173, 234

Photographers in the section made 310 field trips into the States of Maine, New Hampshire, New York, Maryland, and Virginia.

Reimbursement from bureaus for material.....	\$9, 907. 13
Prints sold to public.....	1, 233
Bromide enlargements sold.....	12
Lantern slides sold.....	26
Photostats sold.....	87
Reimbursement from sales.....	\$193. 25

MIMEOGRAPHED AND MULTIGRAPHED WORK

Segments of type set for multigraphing.....	9, 325
Stencils cut.....	15, 438
Multigraphed pages.....	23, 166, 555
Mimeographed pages.....	31, 776, 572
Rotaprinted pages.....	3, 801, 440
Total pages.....	58, 744, 567

APPROVED MANUSCRIPTS PREPARED BY DEPARTMENT EMPLOYEES PUBLISHED IN
OUTSIDE MAGAZINES

Agricultural Economics	113
Animal Industry	86
Biological Survey	209
Chemistry and Soils	140
Dairy Industry	31
Entomology	169
Experiment Stations, Office of	4
Food and Drug Administration	80
Forest Service	242
Home Economics	35
Information, Office of	12
Plant Industry	259
Plant Quarantine and Control Administration	1
Public Roads	115
Total	1,496

PRESS SERVICE

With newspapers, farm journals, magazines, feature writers, and syndicate services demanding agricultural information in increasing quantities, and the department naturally producing more and more information as it expands its research and regulatory work, there is manifest throughout the department a greater appreciation of the importance of the press in the development of agriculture. Some bureaus have long had information specialists to work with the press service in preparing news articles, features, and photos, with the result that the work of such bureaus has received much more attention in the press. Recently other bureaus have added men to their editorial staffs for such work, and still others are planning to do so soon. The ideal arrangement, and one specified by department regulations, calls for a man in each bureau whose duty it is not only to familiarize himself with the work of the bureau but with the wants of the press; one who would work closely with the press service in its efforts to disseminate the results of department research and investigation effectively and promptly.

ONE THOUSAND ONE HUNDRED AND FIFTY REGULAR RELEASES

During the year the press service prepared and issued for the various bureaus 1,150 regular releases, as compared with 1,013 the previous year. A number of articles were prepared upon special request. In addition to the mimeographed releases, 52 issues of the weekly Clip Sheet, each containing about 10 short articles, were sent to approximately 5,000 publications, editors, and free-lance writers. A multigraphed service, page, line, and paragraph, based on a variety of bureau material, was issued each week especially for the use of county-seat and small-town weekly and semiweekly newspapers. Each month from 10 to 14 special illustrated articles on household subjects, obtained mostly from the Bureau of Home Economics, were supplied to seven publications of large circulation. Other publications were circularized with a list of the month's offerings of this material so the editors might select what fitted their needs. The press service also issued, for the information of department em-

ployees and cooperators, 52 issues of The Official Record and 303 issues of the Daily Digest. Many of the 200 press correspondents and free-lance writers stationed in Washington called at the press service frequently throughout the year for agricultural information, photographs, and suggestions for features.

SPECIAL CAMPAIGNS

Several campaigns, undertaken by the Extension Service and department bureaus, required the assistance of the press service. For example, a series of articles issued for the press in the cotton States supported the Federal and State extension services in the move to encourage the production of food for man and livestock on land not adapted to cotton.

DISTRIBUTION OF PRESS MATERIAL

The press service maintains a highly classified mailing list comprising more than 20,000 names and addresses of newspapers, trade journals, farm papers, free-lance writers, and correspondents and other individuals so that it is possible to reach the most effective medium promptly no matter what bureau is being served. A clipping service, covering some 500 publications, serves as a check on the kind of press service material accepted by the press and the extent to which it is used.

Among the most important mediums for the dissemination of department news and information are the illustrated feature pages issued by the various syndicate services. These organizations supply news and featured articles to thousands of newspapers, and cooperation between their representatives and the press service is mutually beneficial. During the year one of these services, which supplies the "boiler plate" for more than 3,000 country newspapers in 48 States, used more than 1,000 articles prepared by the press service. For the last 36 weeks another has been given a special weekly feature called Uncle Sam's Planting Pointers, prepared by a group of specialists in the Bureau of Plant Industry. Still another used 4 to 6 articles a week, many of them illustrated. A fourth issued full-page layouts of news pictures, many of them supplied by the press service to illustrate the work of the department. An innovation in the feature field in which the press service has taken a keen interest is an illustrated line-drawing strip, which daily illustrates some activity of the Federal Government.

NEWS PHOTOGRAPHS

Illustrative material is always in demand by the press, and the press service regards the news photograph as one of the most effective means of attracting interest to the newer developments in agriculture. The assignment of a photographer to the press service for part-time work resulted in a larger quantity of good news pictures than it had been possible to obtain previously. In all, 252 negatives were made and released for use by the press, photographic services, and feature writers.

PRESS SURVEY

The press service completed during the year a comparison of the agricultural copy published in a sample of the daily press for the last seven days in June, 1929, and for the corresponding week in 1919. From June 24 to June 30, 1919, the 31 daily newspapers included in the survey printed a total of 13,532 column-inches of agricultural news, feature articles, editorials, market reports, and miscellaneous items related to agriculture. In the corresponding week in 1929 the same papers printed 21,812 column-inches of comparable material, an increase of more than 61 per cent in the space devoted to the agricultural chronicle. The market reports did not vary so much as did other classifications, and occupied approximately 38 per cent more space in 1929 than in 1919. Exclusive of market reports, the classifications accounted for 6,494 column-inches in 1919 and 12,066 in 1929, an increase of 85 per cent. The "news" classification included 4,794 column-inches in 1919 and 9,083 in the corresponding week in 1929, an increase of a fraction less than 90 per cent. "Features" in these 31 newspapers accounted for 877 column-inches in 1919 and for 1,714 column-inches in 1929, an increase of 95 per cent. Editorial articles increased from the equivalent of 469 column-inches to 812, a 73 per cent increase. Miscellaneous items took nearly 30 per cent more space in 1929 than in 1919, or 457 column-inches as against 353 column-inches.

In initiating this survey the Office of Information believed that it would develop statistical evidence of value to the press service and to the Office of Information, to other organizations of the Department of Agriculture, and to editors and publishers. The comparison serves as a check on the activities of the press service and other informational agencies of the department, and indicates the response by the daily press. It serves as a quantitative indicator of the reaction of the press to what is commonly known as the "agricultural problem." It indicates that editors are willing to and do serve agriculture. This emphasizes the necessity of public agencies seeing to it that the newspapers are supplied with accurate agricultural information. The detailed survey is available in the files of the Office of Information.

RADIO SERVICE

The fiscal year 1930 saw great development of department radio broadcasting, and the marking out of the lines on which future development of this work will proceed.

Radio serves the department and its farmer constituents in two ways—as a quick instrument for getting "rush" information to millions of farm homes and as a means of making vivid and understandable the department's recommendations of improved farming and home-making practices arising from research. Expansion in two fields continued during the past year—in network broadcasting direct from Washington and other key points on the national chains of radio stations and in syndicate service to individual stations.

Network broadcasting made the most significant growth of the year. It was marked by the opening of the National Farm and Home Hour, a daily radio program through a net work of 38 sta-

tions associated with the National Broadcasting Co. On July 8, 1930, the Farm and Home Hour opened after a nine months' experimental program through 17 NBC stations in the Midwest and Southwest. Other new network programs of the year were a weekly series, Safeguarding Your Food and Drug Supplies, delivered through a chain of 13 eastern and southeastern stations by W. R. M. Wharton, chief of the eastern district of the Food and Drug Administration, and a similar series delivered through a chain of 3 Pacific coast stations by W. W. Vincent, chief of the western district of the Food and Drug Administration. Both are presented through the cooperation of the National Broadcasting Co. and its associated radio stations. They are to continue until at least 39 programs have been presented.

Special network presentations arranged by the Radio Service outside the regularly scheduled series of the year included a silver anniversary program for the Forest Service, carried by a coast-to-coast network of 34 stations, and the third annual National 4-H Club Camp Radio Night program used by a network of 33 stations.

In the syndicate programs most of the titles of the previous years were continued. Two new ones were added and one 1928-29 program dropped. Uncle Sam at Your Service, a weekly 10-minute program contributed by the Food and Drug Administration, and Your Farm Reporter at Washington, a daily agricultural program from the department and the Federal Farm Board, were the additions. The Radio Farm Forum, a daily 10-minute agricultural program, was dropped, being replaced by Your Farm Reporter at Washington.

In order to utilize most effectively the valuable radio time contributed by cooperating radio stations, the department has been prompt to invite other agencies of the Government having valuable information on farming or home making to join in its program. The Federal Farm Board has contributed a weekly syndicate program and also a weekly network program in the department series. The Children's Bureau of the Department of Labor has contributed a weekly syndicate program. The United States Army Band and the Marine Band occasionally contribute musical numbers to the network programs.

NETWORK PROGRAMS

The National Farm and Home Hour, set up in cooperation with the National Broadcasting Co., is delivered each day except Sunday from 12.45 to 1.30 p. m., eastern standard time. That company provides 25 minutes of entertainment features in the typical daily program, the United States Daily four minutes of governmental news, and the department or the Farm Board 16 minutes of agricultural information. The arrangement is flexible, however, and on occasion the entire 45 minutes of the program has been devoted to an information broadcast, notably on January 28, 1930, when Secretary Hyde, Chairman Legge, of the Farm Board, and members of the Bureau of Agricultural Economics summarized the 1930 Outlook Report.

The National Broadcasting Co. provides the network facilities without charge for the National Farm and Home Hour and also provides the musical portions of the daily programs not otherwise arranged for. The company likewise defrays all broadcasting expense for the Food and Drug Administration network series and for the

special broadcasts arranged from time to time. The stations in the network contribute their broadcasting time without charge.

RESPONSES TO PROGRAMS

The response to network programs increased during the past year. From July 8, 1929, to June 30, 1930, letters from National Farm and Home Hour listeners clearing through the radio service numbered 35,634. Probably five times as many letters inspired by these programs reached the department as a whole as came directly to the radio service.

W. R. M. Wharton, from March 4 to June 24, in his weekly talk, Safeguarding Food and Drug Supplies, inspired an average of 250 letters per week from the radio audience. His total listener response to June 24 was 3,548. His talks excited favorable comment from the trade journals, which foresee benefit to the industries from a rising tide of intelligent reading of labels by consumers. Similar interest attaches to Mr. Vincent's series through the western network.

Response to the syndicate services also showed a substantial increase during the year. From October 1, 1929, to June 30, 1930, 88,315 letters from listeners to syndicate programs were received in the radio-service office. Here again, the volume of mail handled in that office represents only a fraction of the department correspondence inspired by radio; neither does it accurately indicate all the contacts between field representatives of the department and the State extension services and individual farmers and home makers.

SYNDICATE PROGRAMS

The total number of stations assigned syndicate services on June 30, 1930, was 191. Of these, 134 were broadcasting the daily Housekeepers' Chat; 109 the daily Farm Flashes; 66 the daily Farm Reporter at Washington; 98 the weekly Uncle Sam at Your Service; 85 the weekly Primer for Town Farmers; 88 the weekly Farm Science Snapshots; 110 the biweekly Chats with the Weather Man; 83 the biweekly With Uncle Sam's Naturalists; and 107 the monthly Agricultural Situation Review.

WIDE RANGE OF SUBJECTS DISCUSSED

The syndicate and network broadcasts cover the wide range of the department's activities and reflect its phases most important in the daily life of the American farm or city family. The important economic reports of the department, which must be placed in the hands of millions of farmers soon after they are issued in order to be of maximum value, constitute a most important part of the network programs. The monthly crop reports, the report on the agricultural situation and that on the price situation, and the especially prepared monthly reviews of the market situation for the major farm commodities are carried regularly in the National Farm and Home Hour. All outlook reports are sent as issued. Similarly announcements of new quarantines or revisions of existing quarantine regulations; reports at appropriate times on the extent and seriousness of such diseases as hog cholera, along with recommendations for control, are scheduled in the network broadcasts.

Recommendations of the department for improvement in farm and home practices also are distributed by speakers in the network programs at appropriate seasons. In all, during the past year, 247 members of the department addressed rural America, some of them several times, during the daily Farm and Home Hour programs.

In the syndicate programs attention is given more especially to advancing the knowledge of improved farming and home-making practices, and to explaining to the rural public the reasons which actuate the government in undertaking such enterprises as tuberculosis eradication, white-pine blister rust control, and barberry eradication, and the methods used in conducting these programs.

NEED FOR LOCALIZING PROGRAMS

Nearly all phases of the department's work have been represented in the broadcasts of the past year. But the emphasis has been placed upon the results of the work in recommended farm and home practices, and upon such findings as will guide farm business operations, rather than upon the extent or method of the work. The aim has been to get before the public facts it can immediately use.

The stressing of the extension aspects of the department's work points to the direction of future development of the department's broadcasting. Surveys indicate that radio has come to be accepted as a part of the farm business equipment and that farmers look to it as an introducer—not as a complete educator—just as they look upon the poster and the exhibit, for example. The present task of the Department of Agriculture in its extension broadcasting is to bring the local radio stations with which it has contact into closer relation, not with Washington, but with the State agricultural college and its extension field force. When the agricultural colleges are equipped with the editorial personnel to work with the department radio writers, the department radio service should turn over contacts with individual stations to the colleges and become a service agency to them, rather than direct to the stations. Its task will then be to provide department information not available at the State agricultural college, prepare it for effective radio presentation, and supply it to the college to be incorporated in the college radio program through stations in its State.

The aim is maximum service to the farmer and home-maker listener. Radio needs the backing of the detailed instruction power in the extension organizations of the several States; the extension organizations of the States can expand the effectiveness of their work by using the attention-getting and action-compelling power of radio. The department's experience has amply demonstrated that the broadcasting business stands ready to cooperate in service to agriculture.

The department logically should continue to issue economic and emergency fact broadcasts through the networks. It will, with the help of the National Broadcasting Co., meet the regional information needs of the network listeners, and will try to work out methods of local station cooperation with State extension services which will enable the listener to get at one period both national and local economic analysis and production practice recommendations.

INFORMATION WORK OF THE BUREAUS

While practically all information material clears through the Office of Information, most of it originates in the bureaus. Some of the bureaus, the nature of whose work requires it, maintain direct informational contacts with the public. By this means they give prompt publicity to weather and crop reports, market data, administrative regulations affecting plant and animal quarantines, forest-fire conditions, trading in the grain futures markets, and so on. All the bureaus and offices of the department recognize that agricultural knowledge to be fruitful must be communicated to the public.

Information must be considered in the light of subject matter and the effectiveness with which the subject matter reaches those who can use it. A few examples of bureau information work during the fiscal year 1930 will indicate the scope, volume, and effectiveness of the year's efforts.

AGRICULTURAL ECONOMICS

Ever-increasing emphasis is placed upon the economic phase of agriculture. Economic improvement, depending as it does on widespread collective action, calls for intensive informational work. The advent of the Federal Farm Board brought about during the year a great extension of activities in economic information. Since the policy of the board was to conduct educational campaigns on crop adjustments and cooperative marketing through the Extension Service agencies of the department and the States, it became necessary for the Bureau of Agricultural Economics to extend its informational work. The campaigns to adjust the acreage of cotton, tobacco, and wheat necessitated the preparation and distribution of thousands of copies of special publications, press releases, radio releases, and statements in mimeographed form. To keep the public currently informed the bureau issued each month its periodicals *Crops and Markets* and the *Agricultural Situation*; price analyses and crop estimates were issued regularly.

The Bureau of Agricultural Economics is charged with the operation of two national systems of agricultural fact-gathering and distribution work—the Federal-State crop and livestock estimating service and the Federal market news service. Each required a special staff of workers in Washington and at field stations located in the States.

The crop and livestock estimating service was strengthened during the year by the addition of several new workers and the inauguration of a new series of reports on fruit and truck crops. This series supplies the facts of crop production and condition not heretofore available. Many of the State statisticians have extended their informational activities in relation to the press, radio, and extension service, so that crop reports are now obtainable by all public agencies from either the Washington or field offices. The desire for prompt delivery of these reports makes it necessary to give rapid distribution. In some instances over a ton of paper is used in issuing a single report, this quantity being mimeographed and mailed within a few hours of the issuance of the report.

The collection and distribution of daily market reports in the principal markets for farm products was extended to cover some markets and distribution points not previously served. The leased-wire system, which now exceeds 10,000 miles, was extended to Nashville, Detroit, Cleveland, Portland, Oreg., Seattle, Spokane, and Boise. The leased-wire system is rapidly becoming the spinal cord of a complete national system of market news which will cover all principal markets with a daily service. Information is now being relayed to radio stations and other points not on the leased wire for prompt distribution. The reports issued by the bureau now cover almost every crop of any commercial importance.

Economic information is in particularly urgent demand in periods of depression and low prices such as now prevail. The press has given more space than ever before to such material, and radio programs have been rapidly expanded. In addition, Congress has appropriated over \$1,000,000 for economic extension work, which will call for a greatly enlarged program of economic publications. Members of the staff of the Bureau of Agricultural Economics were called upon to make many addresses and to prepare a large number of special articles for magazines. The correspondence of the bureau is growing annually, and a large amount of original economic information is distributed in this way. Many questions require considerable study for reply and lead to the publication of useful reports of general interest.

ANIMAL INDUSTRY

The Bureau of Animal Industry contributed 98 papers on various phases of livestock work to technical and agricultural periodicals. These were in addition to its official publishing through the Office of Information, which comprised 157 new and revised documents. Intensive informational work was done by the bureau in the administration of livestock laws. A vigorous campaign was carried on to acquaint the livestock industry and the general public with the object of the tuberculosis eradication campaign and with the reasons for various measures adopted for the suppression of animal diseases and the improvement of livestock. Regulations issued under the various regulatory laws were accompanied by information designed to secure public cooperation. Especially effective work has been done in counteracting skepticism as to the tuberculin test. So favorable had the attitude of livestock owners toward the tuberculosis-eradication campaign become that testing at the rate of about 1,000,000 animals a month did not eliminate a waiting list representing about 2,000,000 cattle. Information given to the public aided the bureau in its cattle-tick-eradication campaign. The bureau crystallized its recommendations and principal policies in a booklet. It issues quarterly a mimeographed compilation entitled "The Extension Animal Husbandman," which discusses promising new projects and gives the results of research and demonstrations. This compilation has helped in coordinating Federal and State animal-husbandry work and in repeating the successful experience of one locality in others. The better-sires campaign was advanced by press material, posters, and radio and other addresses; at the end of the fiscal year 17,412 participants, owning 585,194 head of breed-

ing stock, were enrolled to use purebred male breeding animals exclusively. Through correspondence the bureau helped State and municipal authorities, schools, and individuals. It called special conferences which had noteworthy influence on animal-disease control, on the management of livestock in various regions, on investigations concerning the quality and palatability of meat, and on trade practices in the livestock market.

BIOLOGICAL SURVEY

In addresses over the radio and before gatherings of such organizations as the Isaak Walton League of America, the American Game Protective Association, State game conservation commissions, forestry associations, and scientific societies, members of the Bureau of Biological Survey sought public cooperation in the conservation of wild life. They showed how individuals and groups can help, and why they should. Problems in pest control and in the preservation of desirable forms of wild life were explained in lectures to college classes, in material especially prepared for livestock associations, and in bulletins, press releases, and radio talks. The results of research in the protection of fur animals in captivity were given in mimeographed leaflets and in articles for magazines and encyclopedias, as well as in department publications. Both English and German editions of a publication on the fur resources of the United States were issued for use at the International Fur Trading Exposition held at Leipzig, Germany (1930). The bureau's annual poster, *Open Seasons for Game*, was made available for publication in outdoor periodicals. One such publication ran the poster in several monthly issues. Another publication purchased copies from the Government Printing Office for distribution to its readers in a special edition larger than the total edition printed for free distribution by the department.

CHEMISTRY AND SOILS

The Bureau of Chemistry and Soils increased its output of information greatly during the year. Through the Office of Information it issued 48 soil-survey reports, 8 technical bulletins, 3 circulars, 1 miscellaneous publication, and prepared many articles for the *Journal of Agricultural Research*. Soil-survey reports described and mapped soils in 20 different States and covered many million acres. These reports proved valuable to farmers in solving local soil problems. Scientific workers in the bureau contributed more than 100 articles to technical and scientific journals. The bureau answered 42,000 letters requesting information. It sent speakers to numerous gatherings of scientists, farmers, manufacturers, and others. The bureau issued, through regular channels, an increased amount of information to the press, particularly on the utilization of farm by-products, on fertilizer practice, and on farm fire protection, thereby winning indispensable outside cooperation. Wide publicity given to a recent demonstration by the bureau, that the supposed danger of gossypol poisoning from the use of cottonseed cake as feed for livestock does not exist, encouraged an increased commercial utilization of cottonseed meal. It was recently demonstrated that a large part of the by-products of wool scouring, heretofore disposed of as sewage

at a total loss, can be utilized for currying leathers, waterproofing canvas, and other purposes. This discovery might have been long delayed had the bureau not obtained, through publicity for its experiments, the cooperation of many wool manufacturers in developing improved methods of scouring and in utilizing the grease and potash obtained from raw wool.

DAIRY INDUSTRY

Information work done by the Bureau of Dairy Industry brought concrete results. In one case the bureau prepared a press release announcing that it had developed a new process for making casein and offering to demonstrate the process at manufacturing plants. In response to this offer the bureau received more than 200 inquiries. Many were from casein manufacturers, paper mills, and trade journals in the dairy and paper fields. The bureau assigned six casein specialists to demonstrate its casein-manufacturing process in factories. This has now been done in factories in a dozen States. At several plants the bureau's grain-curd process has been put into operation. This method, which gives what is known as grain-curd casein, meets the requirements of users who must have a high-grade product. This country uses about 50,000,000 pounds of casein annually, more than half of which is imported. The use of the new grain-curd process will enable American casein to compete with the best casein produced abroad. The substitution of domestic for imported casein in the United States would provide an outlet for a billion pounds of skim milk and buttermilk in addition to the quantity already used for casein in this country. A similarly wide response followed the issuance of a press release describing a new system developed in the bureau for milking cows in large dairy herds. Besides preparing press material and an increased number of publications, members of the bureau wrote 31 articles for scientific, technical, and general publications; gave numerous addresses at colleges and universities; attended many conferences on dairy problems; and took part in radio programs. They conducted extensive correspondence covering every phase of the dairy industry from herd improvement to the disposal of waste from dairy plants.

ENTOMOLOGY

In addition to a greatly increased distribution of popular bulletins on entomological subjects, and an increased volume of information through press and radio channels, officials of the Bureau of Entomology were called upon to answer 34,428 inquiries by letter during the year. Members of the staff also contributed about 170 articles to outside publications, and they made 129 addresses. The bureau is badly in need of an entomological periodical for distribution to cooperating scientists and institutions.

EXPERIMENT STATIONS

The Office of Experiment Stations conducted information work relating primarily to the organization and progress of agricultural research. An important item in this work is the publication of the Experiment Station Record, which gives a current review of the

technical publications of the department, of the agricultural experiment stations, and of the scientific agricultural publications throughout the world. The Office of Experiment Stations also prepared publications on personnel matters and issued reports on the income, expenditures, organizations, equipment, and work of the experiment stations. It conducted a large correspondence, supplemented with personal conferences, regarding research projects and programs. It maintained an information service looking to the improvement of local agricultural practices in Alaska and the insular possessions. It supervised the preparation of bulletins and reports on the work of the experiment stations in Alaska and the insular possessions and helped to outline farm-improvement policies for the regions represented.

EXTENSION WORK

Improved presentation of subject matter, more use of illustrations, emphasis on brevity, and better make-up characterized extension publications during the last fiscal year. County extension agents distributed 6,345,488 publications. The State extension divisions published and paid for from their funds 1,709 documents. These consisted of 242 bulletins, 366 circulars, and 1,101 miscellaneous publications. The office of cooperative extension work prepared reports on cooperative extension for 1926 and 1927, and also 11 printed circulars, 23 mimeographed circulars, and 221 miscellaneous duplicated publications. A new monthly periodical, the Extension Service Review, was started during the year in response to a long-felt need. News service in relation to extension work was much increased. County extension agents wrote more than 400,000 news stories for the press. The office of cooperative extension work cooperated with the press service in assembling and preparing 63 articles for The Official Record and for release to the press. (See the Annual Report of the Director of Extension Work.) Radio broadcasting by the office of cooperative extension work was increased greatly. Forty-five stations are now giving a monthly 4-H Club program. From August to December, 1929, eight States cooperated in giving similar radio programs.

FOOD AND DRUGS

For the first time an extensive educational program was last year undertaken to inform consumers by means of the radio of the significance of label statements on food and drug products coming within the jurisdiction of the Federal food and drugs act. The department does much work every year to bring about truthful and informative labeling on food and drug packages, but unless consumers read label statements carefully and intelligently they can not realize the full benefits of food and drug law enforcement. The food and drug officials have long felt the need of giving to consumers information that would be helpful to those who desired to be discriminating buyers. A weekly series of talks on label reading was broadcast from New York over a chain of stations by the chief of the eastern inspection district of the Food and Drug Administration. Likewise, the chief of the western inspection district in San Francisco gave a series of read-the-label weekly talks over a network of stations on the Pacific coast. Weekly talks by the "veteran inspector" on food and

drug law enforcement topics were prepared by the radio service of the department upon information furnished by the specialists of the Food and Drug Administration and were used during the entire year by many broadcasting stations. Occasional radio talks were given by specialists of the Food and Drug Administration, all aimed to acquaint consumers with the requirements of the Federal food and drugs act and how they might avail themselves of the benefits accruing from the enforcement of the act. Most of these talks were published in mimeographed form and distributed upon request to those interested. Especially wide distribution was obtained for the mimeographed material giving information regarding label reading. The large number of requests received for this material from radio listeners indicates that consumers are deeply interested in learning more about the foods they buy. The press was also supplied with an increased amount of material, the result being a greater public appreciation of and cooperation in this regulatory work.

FORESTRY

The Forest Service attached much importance to its informational activities. Forest preservation and development depend quite as much on the dissemination as on the growth of forest knowledge. This is because about four-fifths of the forest land of the United States is privately owned; forest owners and forest users must apply forest science, or its practical value is small. Knowledge of fire-prevention rules, particularly, is important. About 31,000,000 persons visited the national forests in 1929, and since 90 per cent of the forest fires that break out annually in the United States are caused by man, largely through carelessness, it is necessary to reach these visitors with information on how to use the forests. Educational and informational work was done during the year by every forest officer in addition to his special assignment. Specialists in the Forest Service wrote 242 articles for magazines, trade journals, and technical publications. Members of the Washington staff gave special information in interviews to 217 authors, press representatives, and others. Members of both the Washington staff and the field organization addressed numerous scientific groups, civic organizations, and clubs. They furnished technical help to various industries and cooperated in informational work with State forestry departments and with other agencies and organizations interested in forest welfare. The Forest Service issued, through the Office of Information, 62 publications, including reprints, during the fiscal year 1930. These publications had a combined edition of 835,500 copies. The Forest Service issued a bimonthly magazine called *The Forest Worker* which reported forestry news, carried Federal and State announcements of interest to foresters, and contained articles on new developments in forestry. A weekly house organ, distributed to 2,700 employees, was published. Similar bulletins were issued by several regional offices of the Forest Service. Much radio broadcasting was done during the year. Forest programs were also broadcast by regional officers of the Forest Service. Both the Washington office and the regional offices issued numerous press releases through the department's press service and other

channels. Printed material and speakers were furnished for various State forest weeks. Letters written during the year in response to special requests for information totaled more than 2,300 in the Washington office alone. A large correspondence of a similar character was carried on by the 9 regional offices of the Forest Service, by its 13 regional experiment stations, and by the supervisors' offices. From a photographic collection that contains more than 50,000 pictures, the Forest Service supplied newspapers, book publishers, and others with more than 2,400 prints. It also did much informational work in cooperation with women's clubs, young folks' organizations, and schools.

GRAIN FUTURES

The Grain Futures Administration issued daily reports on trading in futures. These reports showed the daily volume of trading done and the total of the open commitments in each grain future. They were issued in Chicago, Minneapolis, Duluth, and Kansas City, the most important grain-futures markets of the United States. For seven smaller futures markets reports were issued monthly. These reports were all distributed through the daily press, through trade journals, and through market news agencies. They reached practically everyone who desired such information. In addition the Grain Futures Administration gave much information in response to direct inquiries from farmers, economists, editors, students, and others concerning the complicated machinery of trading in grain futures. Most of these inquiries called for special research.

HOME ECONOMICS

In the last fiscal year the Bureau of Home Economics added 12 new bulletins and 2 series of charts to its technical and popular publications. These dealt with foods and nutrition, textiles and clothing, and the economic problems of the home. The bureau furnished nearly 200 articles for syndicates, small-town weeklies, and farm magazines. It supplied more than 200 photographs to various publications. Members of the bureau made 45 radio talks in the regular Farm and Home Hour. One dialogue on meat cooking brought 21,000 requests for the bureau's leaflets on that subject. The bureau issued many releases in the Housekeepers' Chat series. It answered more than 20,000 personal letters, double the volume of mail handled two years earlier. Articles contributed by the bureau to the department's Yearbook and to scientific and popular magazines dealt with such subjects as nutrition, textile chemistry, clothing, diet, and general research in home economics.

LIBRARY

The library of the department issued various current lists, and also bibliographies on subjects of special interest in the work of the department. The principal accessions were noted each week in the Official Record. In cooperation with the State agricultural college and experiment station libraries, the library issued a mimeographed publication called Agricultural Library Notes, which contains lists

of the more important new books on agriculture, notes of recent bibliographies, lists of new mimeographed publications of the department, lists of duplicates, and special articles on agricultural library work. Several special compilations were issued by the branch libraries in the bureaus, such as a monthly mimeographed publication called *Agricultural Economics Literature*, a bimonthly list of forestry literature, a mimeographed list on botany and another on agronomy, and a weekly mimeographed list called *Highway and Agricultural Engineering Current Literature*.

PLANT INDUSTRY

The Bureau of Plant Industry furnished 57 papers to the *Journal of Agricultural Research*. Members of the bureau's staff contributed 296 articles to outside publications. They answered numerous inquiries by letter, usually about subjects on which no available official publication gave the desired information. The bureau cooperated with the Office of Information in issuing information on plant science in the form of press articles, radio broadcasts, and addresses. It published a semimonthly periodical called the *Plant Disease Reporter*, which gave the results of plant-disease surveys made regularly throughout the country. The results of its work, presented in both technical and popular form, are issued mostly through the department's division of publications. The bureau furnished text for 170 publications during the year and handled 232 reprints and revisions of earlier publications.

PLANT QUARANTINES

The Plant Quarantine and Control Administration used many informational means of winning public cooperation in the enforcement of quarantines. Members of the organization personally gave instructions to shippers and common carriers about plant-quarantine restrictions. They gave talks at county and local agricultural gatherings on the control of such pests as the Mediterranean fruit fly, the European corn borer, the Japanese beetle, and gipsy moth. To enlist the cooperation of the merchants, addresses, posters and maps, radio talks, and other means of communication were used. Posters gave summaries of quarantine regulations and indicated the quarantined areas. Information thus given was of immediate practical value to farmers, nurserymen, and commercial agencies and also to the general public. Quarantine restrictions gave rise to a large correspondence which served as a valuable channel for information. The administration obtained a wide circulation through the press for its regulatory announcements. Officers of the administration found it necessary to combat misapprehension about plant quarantines. Much of the cost of eradicating plant pests or of checking their spread falls inevitably on the growers and the shippers. Accordingly, those in charge of the work devoted much attention to explaining the nature and value of proper enforcement. Effective publicity was one of the most important factors in the substantial success gained in some recent campaigns for the control of plant pests.

PUBLIC ROADS

The Bureau of Public Roads supplied information resulting from its researches relating to highway materials, highway design and construction, and highway economics and transport. It did so largely through a publication called *Public Roads*, distributed to highway engineers and officials. The periodical is known to highway engineers throughout the world. The bureau collected and distributed statistics on highway income, on expenditures, on mileage, on motor-vehicle registration and taxation, and on gasoline taxes. It furnished material for use in economic studies and in business analyses. Members of the bureau gave lectures in short courses in highway engineering at many educational institutions. Research results obtained in agricultural-engineering investigations were disseminated by correspondence, bulletins, and addresses, and at farmers' weeks and in farmers' short courses. Some inquiries received in correspondence were answered by sending farmers' bulletins to the writers. Other requests demanded individual treatment. The correspondence dealt with many phases of irrigation, drainage and erosion, farm structures, farm machinery, and land clearing. The bureau supplied a steady and increasing demand for plans of buildings and barnyard equipment. Specialists wrote 115 articles for outside publications, chiefly technical periodicals.

WEATHER BUREAU

The Weather Bureau collects, charts, and distributes weather reports daily from a network of observing stations. Daily forecasts and weather maps are distributed by several divisions of the Washington office and by 300 field stations. This information found its greatest single outlet through the press. Radio was extensively used. The Weather Bureau issued an annual report giving monthly and annual means and extremes of temperature, rainfall, snowfall, and other weather data. It published a periodical called the *Monthly Weather Review*, which gives weather statistics of the United States and the adjacent oceans. This publication is now in its fifty-eighth year. The Weather Bureau also issued monthly and annual climatological data for each State and combinations of States and also for Alaska, Hawaii, the West Indies, and the Caribbean regions. In the winter months it issued a snow and ice chart, showing the depth of snow in various regions and the thickness of ice in the larger rivers. The bureau's members gave many addresses and conducted a voluminous informative correspondence.



REPORT OF THE LIBRARIAN

UNITED STATES DEPARTMENT OF AGRICULTURE,
OFFICE OF THE LIBRARIAN,
Washington, D. C., August 21, 1930.

SIR: I submit herewith the report of the library for the fiscal year ended June 30, 1930.

Respectfully,

CLARIBEL R. BARNETT,
Librarian.

HON. ARTHUR M. HYDE,
Secretary of Agriculture.

INTRODUCTION

The tables which appear at the end of this report have been compiled from the reports submitted by the heads of the divisions of the main library and the reports of the branch libraries in the various bureaus. They give a detailed synopsis of the routine work of the library as a whole, in so far as this can be expressed in statistical terms, and they make it possible to compare the progress of the past year with that of previous years. These tables show the number of accessions to the library, the number of items catalogued, the cards added to the various catalogues, the record of periodicals received, the number of books bound, the statistics of circulation, the principal statistics regarding the bureau libraries, the number of the library staff, and the financial statistics. Some of the high points in the work expressed by these statistics will be mentioned here, followed by the account of the bibliographical work, the legislative reference work, the work of the bureau libraries, and other special activities.

ACCESSIONS

On July 1, 1930, the library contained 218,038 volumes. The scope of the library corresponds with the scope of the work of the department. It specializes, however, in the subject of agriculture and also its various branches, including plant and animal industry, agricultural engineering, forestry, and agricultural economics, and in the sciences pertaining to agriculture, such as chemistry, biology, botany, zoology, and entomology.

The number of books, pamphlets, and maps added during the year was 16,563, which is 2,209 more than the number added the previous year, largely due to the increase in the appropriation. The library continues to be the recipient of a large number of gifts of books,

periodicals, public documents, and society publications, which are highly valued. The number thus received during the past year was 9,548, an increase of approximately 10 per cent. The grateful thanks and appreciation of the department are extended to the donors for their generosity. Similar gifts from others interested in the important work carried on by the department are solicited and will be gratefully received.

CATALOGUING AND CLASSIFICATION

The amount of material catalogued in the main library showed a considerable increase as compared with the amount catalogued the previous year. On the other hand the number of cards added to the catalogue showed a decrease, due to the fact that in the fiscal year 1929 the printing of the cards which had been in arrears was brought up to date by the Library of Congress. The total number of cards added to the general catalogue of the main library and the special catalogues and indexes in the bureau and office libraries was 123,377. Detailed statistics in regard to the cataloguing are given in Tables 1 to 6.

PERIODICALS

The total number of different periodicals received by purchase, gift and exchange was 4,080 as compared with 3,936 in 1929. The number received by gift was 2,885. Of a number of the periodicals it was necessary to purchase additional copies, and extra copies of many of the gift periodicals were also received. The total number received by purchase, gift, and exchange, including the duplicates was 4,536, an increase of 221 over the number in 1929. The total cost of the subscriptions for periodicals was \$9,375.06, or about one-third of the total amount spent for accessions to the library.

No separate record is kept in the periodical division of the number of continuations received but the records of the catalogue division show that 7,364 continuations were catalogued, and it is probable that approximately 6,000 were current issues.

In addition to the current periodicals and serials, the library receives 128 daily newspapers which are not included in the figures given above. Farm bureau publications are also not included. The latter, to the number of 253, are received currently in the Office of Experiment Stations library and at the end of the year are filed in the main library.

More detailed statistics regarding the periodicals received are given in Table 7.

BINDING

The binding statistics are given in Table 8. These show that the number of books and periodicals sent to the Government Printing Office for permanent binding was 3,051, an increase of 858 over the previous year, as more funds were available for binding. An additional 1,093 volumes were prepared for binding during May and June and would have been sent to the Government Printing Office if the department funds for binding had not been exhausted. The number of books and periodicals placed in temporary binders was

2,429. The need for increased funds for binding is urgent. As pointed out in previous reports, the appropriation for this purpose needs to be doubled in order to make up for the arrears in binding in the past few years.

USE OF THE LIBRARY

Detailed statistics of the use of the library, in so far as statistics are available, are given in Tables 9 to 12. They indicate only approximately the use of the library, as exact figures regarding the circulation of periodicals can not be kept under existing conditions in the main library or in the Bureau of Agricultural Economics library. The recorded figures of circulation this past year for the library as a whole show a circulation of 62,984 books and 205,031 periodicals, totaling 268,015. If to these exact figures are added the estimated circulation of current periodicals in the main library and the Bureau of Agricultural Economics library, it is believed that the total circulation would be over 450,000.

Interlibrary loans by the library totaled 2,798. They were made to every State with two exceptions, the largest number being sent to New York State.

Interlibrary loans were granted to the library to the number of 4,824 by 20 libraries in Washington. Interlibrary loans from libraries outside of Washington, totaling 79, were granted by 25 different libraries. To all these libraries the department is greatly indebted for the help received and particularly to the Library of Congress and the library of the Surgeon General's Office. From the Library of Congress 4,073 books were borrowed and 386 from the library of the Surgeon General's Office.

BIBLIOGRAPHICAL WORK

One addition was made during the year to the mimeographed series of bibliographical contributions of the library, namely, No. 20, entitled "Checklist of Publications on Entomology issued by the U. S. Department of Agriculture through 1927, with Subject Index," compiled by Mabel Colcord, Ina L. Hawes, and Angelina J. Carabelli, members of the library staff of the Bureau of Entomology.

In the Bureau of Agricultural Economics library four additions were made to the mimeographed numbered series, Agricultural Economics Bibliographies, as follows:

- No. 28. The strawberry industry in the United States. A selected list of references on the economic aspects of the industry. Compiled by Esther M. Colvin. 52 p.
- No. 29. Valuation of real estate with special reference to farm real estate. Compiled by Emily L. Day. 87 p.
- No. 30. Large scale and corporation farming. A selected list of references. Compiled by Margaret T. Olcott. 87 p.
- No. 31. California. An index to the State sources of agricultural statistics. Part I. Fruits, vegetables, and nuts. An index to the official sources. Compiled by Louise O. Bercaw. Sections 1 and 2. 342 p.; Part V. An index to some unofficial sources. Compiled under the direction of Mrs. M. J. Abbott, Agricultural Reference Librarian, University of California library. 69 p.

Revisions were also made of the following numbers:

- No. 1. Agricultural economics. A selected list of references. Compiled by Mary G. Lacy. Revised April, 1930. 21 p.
 No. 11. Economic periodicals of foreign countries published in the English language. A selected list compiled by Louise O. Bercaw. Revised by M. I. Herb. March, 1930. 26 p.

Forty reference lists were prepared and are available in type-written form. The more important of these are the following:

- The grain industry in the Pacific Northwest. A selected list of references on the economic aspects of the industry. 9 p.
 Printed material on the Southern States, 1910—date, issued by the Bureau of Agricultural Economics and the other bureaus, offices and divisions which carried on economic work in the Department of Agriculture before that bureau was organized. 13 p.
 State official marketing bulletins. Compiled by Esther M. Colvin. 9 p.
 Hops. Selected references on the economic aspects of the hop industry. Compiled by Louise O. Bercaw. 17 p.
 State and Federal publications dealing with the marketing of agricultural products. A list of references to the printed publications of State and Federal departments of agriculture, markets, etc., issued since 1924. Compiled by Louise O. Bercaw. 52 p.

The Bureau of Agricultural Economics library also continued its cooperation with Rural America, organ of the American Country Life Association, in furnishing regularly to that journal lists of recent material relating to the literature of rural life. The monthly publication of the library entitled "Agricultural Economics Literature" was issued throughout the year except in July and August. This publication now goes to 1,000 addresses, including 98 in 31 foreign countries.

In the Bureau of Dairy Industry library work was continued on the revision of Bibliographical Contribution No. 6 entitled "Partial List of Publications on Dairying Issued in the United States, 1900 to June, 1923." It has been decided to include in this revision all the material from the organization of the stations in 1888 up to and including 1930. It will also include all the publications on dairying issued by the Department from its organization up to 1930. The revision, therefore, besides bringing the material up to date, will be enlarged in scope. Dairy Library List No. 2 entitled "Publications of the Department of Agriculture Relative to Dairying Available for Free Distribution" was corrected and reissued four times during the year.

In the Bureau of Entomology library the check list of publications of the United States Department of Agriculture on entomology was completed and issued as Bibliographical Contribution No. 20 of the department library. It covers all the publications through 1927 and comprises 261 pages. The fourth Index to the Literature of American Economic Entomology, covering the years 1925-1929 was completed and it is hoped will be in book form this year. The manuscript comprised 1,985 pages and contained over 30,000 references to American economic entomology. It will be published as Special Publication No. 4 of the American Association of Economic Entomologists. A catalogue of the books, bulletins, and pamphlets on apiculture contained in the library, which was prepared by an assistant of the Bureau of Entomology and an assistant of the main library, in cooperation with the Division of Bee Culture, was com-

pleted a few months before the close of the fiscal year but could not be mimeographed on account of the congestion of work in the duplicating section of the department. It will be issued during the coming year.

In the Office of Experiment Stations library work was continued on the listing of the titles of articles reporting the results of experimental work in the stations which have appeared in scientific and technical journals. A check list of the State agricultural extension publications through 1929 was completed by Helen V. Barnes. This comprises 1,731 typewritten pages. The following bibliographies and lists of references pertaining to extension work were compiled by Mrs. E. J. Webb:

Exhibits: A selected list of State extension and U. S. Department of Agriculture publications. 22 p.

List of extension publications—care and repair of furniture. 2 p.

List of extension publications on plays and pageants. 3 p.

List of references on community singing. 2 p.

A selected list of references on community centers. 3 p.

Selected list of references on traveling exhibits. 7 p.

State extension publications on home management: A selected list of references. 24 p.

Complete lists of the publications of A. C. True, former Director of the States Relations Service, and E. W. Allen, former Chief of the Office of Experiment Stations, were also compiled. The library continued to prepare the monthly List of State Publications and the monthly List of Extension Publications of the State Agricultural Colleges. The fourth biennial supplement to the United States Department of Agriculture Bulletin 1199 entitled "List of Bulletins of the Agricultural Experiment Stations for the Calendar Years 1927 and 1928" was issued as Miscellaneous Publication No. 65. This was compiled by C. E. Pennington.

In the Forest Service library the main bibliographical work was in connection with the index of American forestry literature which is being prepared in cooperation with the National Research Council. It is hoped that the work will be completed and printed within the next six months. The bimonthly mimeographed list of books and articles on forestry indexed in the library was issued throughout the year under the title "Forestry—Current Literature." Several short lists on special subjects were prepared during the year, among the more important of which were the following: Dry rot, Eucalyptus, Fire damage, Forest soils, Forests and land utilization, Grazing, Philippine hardwoods, Monterey pine, Port Orford cedar, Sequoia.

In the Bureau of Plant Industry library a List of State and Local Floras of a Popular Type, compiled by Alice C. Atwood, with annotations by S. F. Blake of the bureau, was completed and was published in April, 1930, as Bulletin No. 1 of the Wild Flower Preservation Society. A selected list of references on Sunflower (*Helianthus annuus*), compiled by Marjorie F. Warner, was issued as a supplement to Agricultural Library Notes, vol. 5, No. 1-3. The work on a bibliography on genetics in relation to plant breeding has been continued during the past year. Owing to the great quantity of references the form of the bibliography has been changed from a classified list to a straight author arrangement with a minute

subject index. It is hoped that the bibliography will be completed during the coming year. The library continued to issue Botany—Current Literature and Agronomy—Current Literature. The issue of the former at the end of the year was 985 copies, of which 194 were distributed to workers in the department, 724 to scientists outside of Washington, and 67 to scientific institutions or individuals abroad. Agronomy—Current Literature has an issue of 365 copies—93 distributed in Washington, 256 outside, and 16 abroad.

In the Bureau of Public Roads library two pieces of bibliographical work were undertaken during the past year, neither of which has been completed. One relates to roadside development, including billboards, beautification of wayside stands, etc. The other, which is to serve as an appendix to a forthcoming publication of the American Association of State Highway Officials, will be a comprehensive bibliography on roads beginning with the early laws and road work in the Colonies and following the development of road building to the present time. The Partial List of References on Toll Bridges was revised, in October, 1929. Short bibliographies have also been prepared in response to specific requests, among them the following: Prequalification of Bidders, Electricity on the European Farm, Partial List of References on the History of Transportation, and Effect of Improved Highways on Real Estate Values. In addition to the special lists, the weekly list of current literature entitled "Highways and Agricultural Engineering—Current Literature" was issued regularly. The total circulation of this list is now 277.

LEGISLATIVE REFERENCE WORK

Legislative reference work has been an increasingly important feature of the work of the Bureau of Agricultural Economics library and the Bureau of Public Roads library for the past two years, as they have the responsibility for keeping their respective bureaus informed on new legislation of interest to their bureaus. Records are kept of new bills and resolutions in Congress and copies of the bills, resolutions, hearings, and reports are obtained. The work was particularly heavy during the past year as Congress was in session nearly the whole of the year. The progress of 330 bills and resolutions of interest to the Bureau of Agricultural Economics was followed by the Bureau of Agricultural Economics library. Of this number 102 were passed. In the Bureau of Public Roads library 1,682 bills and resolutions were followed from the time of their introduction. Of this number 245 were passed by Congress. About half of the total number of bills passed by Congress during the past year were of interest to the department.

In the Bureau of Chemistry and Soils library the indexing of the foreign food and drug laws has been continued. Several foreign journals are currently examined for this information.

BUREAU AND DIVISION LIBRARIES

A list of the bureau libraries and various data in regard to them will be found in Table 13. Cataloguing statistics are included in Tables 5 and 6. Statistics of circulation are given in Table 9. Other activities such as bibliographical work, legislative reference work, etc., have been described in the body of the report under these headings.

Nearly all of the bureau libraries report an increase in the reference work. This is particularly true of the Bureau of Agricultural Economics library, as many requests were received from the Federal Farm Board in addition to the requests emanating in the bureau. The activities of the Bureau of Public Roads in connection with the International Road Congress held in Washington in October, 1930, have also made increased demands upon the library of the bureau for information on foreign highway questions.

The special lines of work carried on by some of the bureau libraries which have been described in detail in previous reports as "allied activities" have been continued during the past year with no important changes.

The collection of horticultural trade catalogues, numbering approximately 25,000, which was formerly filed in the Office of Horticultural Crops and Diseases, Bureau of Plant Industry, was returned to the main library in 1929 and is now filed in the new space in the basement. The assistants in charge also have their office in the main library adjacent to the collection.

In the Bureau of Agricultural Economics a new library service was organized in the Division of Cotton Marketing.

COOPERATION WITH OTHER LIBRARIES, INSTITUTIONS, AND ORGANIZATIONS

Agricultural Library Notes, the mimeographed publication of the library, issued in cooperation with the land-grant college and experiment station libraries, has been continued. Six numbers were issued during the past year.

The library again cooperated with the library science division of George Washington University in providing four lectures on agricultural library work in connection with the course in library administration given by the university.

Under a cooperative arrangement, effective July 1, 1929, between the department and the editors of Biological Abstracts, the latter has opened a branch office in Washington and has been assigned office space in the main library. An increase of \$5,000 in the library appropriation was also secured to make possible an increase in the library accessions in the field of biology. F. V. Rand, who is in charge of the Washington office of Biological Abstracts, reports that as a result of this cooperation, about 850 serial publications which have not hitherto been available are now being covered in the abstracting work.

The Bureau of Agricultural Economics library is cooperating with the Bureau of International Research at Harvard University in a demonstration project involving the critical examination of the official economic and statistical publications of a selected list of European countries. It has been asked to compile the titles of the publications in the field which are contained in the library of the department and the Library of Congress. Lists are now under way for Switzerland, Italy, France, Denmark, Rumania, Greece, and Turkey. The library is also cooperating with the Social Science Research Council in working out plans for translating in whole or in part the agricultural economic books of fundamental importance not available in the English language. The librarian of the bureau

has been asked to serve as chairman of the committee which has the project in charge. At the request of the American Country Life Association, the library is compiling a bibliography on rural standards of living. Another cooperative undertaking with this association to which reference has been made elsewhere, is the compilation of the lists of recent material on rural life which are published in *Rural America*, the organ of the association. In response to a request of the acting director of the Giannini Foundation, the librarian of the bureau visited the foundation the last of June and drew up a memorandum containing suggestions for developing its library service. In response to a similar request the librarian of the bureau earlier in the year made a survey of the library needs of the Federal Farm Board.

Other projects being carried on by libraries of the bureaus in cooperation with other institutions and organizations are the Index to the Literature of American Economic Entomology which is being compiled by the Bureau of Entomology library in cooperation with the Association of American Economic Entomologists, the Index of American Forestry Literature carried on in the Forest Service library in cooperation with the National Research Council, the bibliographies being prepared in the Bureau of Plant Industry library in cooperation with the Wild Flower Preservation Society, and the bibliography on roads being prepared in the Bureau of Public Roads library in cooperation with the American Association of State Highway Officials.

LIBRARY ASSOCIATION MEETINGS

The associate librarian of the department and the librarians of of Bureau of Agricultural Economics, the Bureau of Chemistry and Soils, and the Office of Experiment Stations, attended the annual meeting of the American Library Association which was held in Los Angeles, Calif., June 23-28, 1930. The agricultural libraries section of the association held its meeting at the citrus experiment station at Riverside. The program was devoted to a consideration of the publications of primary importance on the economic aspects of agriculture. Seven papers on the subject were presented by members of the library staff and were issued in mimeographed form. The librarian of the Bureau of Agricultural Economics was secretary of the section during the past year. The associate librarian of the department was elected secretary for the year 1930-31.

The librarian of the department attended the meeting of the American Library Institute at Atlantic City in April, 1930.

LIBRARY QUARTERS

In July, 1929, the library acquired an additional 1,605 square feet of space in the basement of the Bieber Building. This provided space for the collection of horticultural trade catalogues previously filed in the Office of Horticultural Crops and Diseases, and was also sufficient for the collection of commercial periodicals previously filed in another section of the basement and for the collection of mimeographed publications of the department. It was not necessary to purchase shelving for the horticultural catalogues as the cases in

which they had been filed in the Office of Horticultural Crops and Diseases were transferred to the library. The library was also fortunate in being able to obtain without charge several walnut book-cases which had been discarded by one of the bureaus of the department. These were sufficient to hold the bound volumes of mimeographed publications. For the unbound publications several steel filing cases were purchased. The mimeographed collection is now in better condition than it has been for several years. For the collection of commercial periodicals new steel shelving was purchased. This made it possible to bring together the whole collection of commercial periodicals which had previously been scattered and much congested. It was regretted that it was necessary to purchase additional shelving at this time on account of the fact that the library will be moved within two or three years to its new permanent quarters, but the shelving purchased was of the cheaper grade and it is believed can later be used to advantage for storage purposes. The moving of the commercial periodicals to the new space made it possible to relieve considerably the congested condition of the shelves throughout the basement.

An additional room comprising 235 square feet of space was also acquired by the Bureau of Agricultural Economics library.

LIBRARY FINANCES

The receipts and expenditures of the library for the past 10 years are given in Table 15. The increases which were provided for the fiscal year 1930 were \$5,000 for books and periodicals and \$1,320 for equipment.

LIBRARY STAFF

The number of permanent employees carried on the staff of the main library at the close of the fiscal year was 35. In addition, there were two temporary employees. The number carried by the bureau and office libraries was 61. Further details are contained in Table 14.

Virginia K. Wharton, who had been employed in the main library since October, 1911, died on September 19, 1929. In addition to this loss, there were four resignations in the main library (two of them library assistants, one an under library assistant, and one a messenger), and three transfers (one of them a junior library assistant, one a minor library assistant, and one a library aid). Two of the transfers were to bureau libraries.

There were three changes in the administrative positions of the bureau libraries. An assistant librarian of the Bureau of Chemistry and Soils was appointed. The librarian of the Division of Agricultural Engineering of the Bureau of Public Roads resigned to accept the position of assistant librarian of the Smithsonian Institution. Emily L. Day, an assistant in the Bureau of Agricultural Economics library, was transferred to the Division of Cotton Marketing in order to organize a library service for the division, and was placed in charge.

Staff meetings, including the staffs of both the main library and the bureau libraries, were held each month from October to June.

It is a special pleasure to record that at the April meeting the speaker was Margaret Demchevsky, library adviser to the Ministry of Public Instruction of Bulgaria.

Grateful acknowledgement is again made to the members of the library staff of the department for their zeal and loyalty, and to the administrative officials, bureaus, and offices of the department for their support and cooperation.

STATISTICS

TABLE 1.—*Accessions, 1929 and 1930*

	1929	1930		1929	1930
Purchases:			From binding periodicals and serials:		
Volumes.....	2, 288	2, 760	Permanently bound.....	1, 372	1, 771
Pamphlets.....	144	180	Binders.....	1, 126	1, 407
Maps and charts.....	4	35			
Serials and continuations.....	639	625	Total.....	2, 498	3, 178
Total.....	3, 075	3, 600	New current periodicals.....	228	237
Gifts:			Total accessions.....	14, 354	16, 563
Volumes.....	1, 260	1, 370			
Pamphlets.....	1, 215	1, 387			
Maps.....	86	52			
Continuations.....	5, 992	6, 739			
Total.....	8, 553	9, 548			

TABLE 2.—*Record of material catalogued, 1929 and 1930*

	1929	1930		1929	1930
Volumes.....	3, 548	4, 130	Current entries.....	228	237
Pamphlets.....	1, 359	1, 567	Changed titles.....	77	96
Maps and charts.....	90	87			
Continuations and serials.....	6, 631	7, 364	Total.....	14, 642	16, 873
Volumes received from bindery.....	1, 372	1, 771			
Volumes in binders.....	1, 126	1, 407	Pamphlets (author cards only)....	201	206
Additions to binders.....	211	214	Reprints (author cards only).....	3, 241	1, 282

TABLE 3.—*Uncatalogued material, 1929 and 1930*

	1929	1930
Purchases:		
Volumes.....	22	40
Pamphlets.....	10	4
Continuations.....	4	7
Gifts:		
Volumes.....	677	867
Pamphlets.....	1, 343	835
Continuations.....	77	380
Maps.....		2
Total.....	2, 133	2, 135

TABLE 4.—*Record of titles prepared for printing by Library of Congress in "Agr." series, fiscal years 1929 and 1930*

	Prepared		Printed	
	1929	1930	1929	1930
Accessions and recatalogued books.....	1, 643	747	1, 640	685
Department publications.....	359	480	381	412
Agricultural periodicals.....	67	191	67	190
Total.....	2, 069	1, 418	2, 088	1, 287

TABLE 5.—*Number of cards added to the dictionary catalogue of the main library and to the special catalogues and indexes of the branch libraries of the department, 1929 and 1930*

Library	1929	1930	Library	1929	1930
Main library, dictionary catalogue	125,376	² 20,989	Forest Service	8,000	8,500
Bureau of Agricultural Economics	14,346	12,397	Bureau of Home Economics	3,251	1,905
Bureau of Animal Industry	(³)	(³)	Bureau of Plant Industry	36,794	26,956
Bureau of Chemistry and Soils	1,346	2,248	Bureau of Public Roads	16,946	21,460
Bureau of Dairy Industry	1,708	1,994			
Bureau of Entomology	10,773	18,938	Total	124,222	123,377
Office of Experiment Stations	5,682	7,994			

¹ Net addition, cards added being 28,910 and cards withdrawn 3,534.² Net addition, cards added being 25,009 and cards withdrawn 4,020.³ Figures not available.TABLE 6.—*Total number of cards contained in the dictionary catalogue of the main library and the special catalogues and indexes of the branch libraries*

Library	Number	Library	Number
Main library, dictionary catalogue	¹ 600,000	Forest Service	¹ 150,000
Bureau of Agricultural Economics	105,171	Bureau of Home Economics	16,500
Bureau of Animal Industry	202,184	Bureau of Plant Industry	¹ 395,000
Bureau of Chemistry and Soils	54,548	Bureau of Public Roads	98,084
Bureau of Dairy Industry	30,487		
Bureau of Entomology	190,096	Total	1,923,911
Office of Experiment Stations	81,841		

¹ Estimated.TABLE 7.—*Record of periodicals currently received, 1929 and 1930*

Item	1929	1930
Different periodicals received by purchase	1,194	1,195
Different periodicals received by gift and exchange	2,742	2,885
Total	3,936	4,080
Additional copies purchased	207	247
Additional copies received by gift and exchange	172	209
Total periodicals purchased, including duplicates	1,401	1,442
Total periodicals received by gift and exchange, including duplicates	2,914	3,094
Total including duplicates	4,315	4,536
Different dailies received	79	128
Extra copies purchased	41	47
Total	120	175

TABLE 8.—*Record of binding, 1929 and 1930*

	1929	1930
Books and periodicals sent to bindery	2,193	¹ 3,051
Volumes laced into binders	1,253	2,429
Current serials added to binders	1,385	1,139
Pamphlets stapled in binders	1,019	875

¹ In addition to the 3,051 volumes actually sent to the bindery 1,093 volumes were prepared for binding during May and June but could not be sent to the bindery as department funds for printing and binding were exhausted.

TABLE 9.—*Combined statistics of circulation, 1929 and 1930*

Bureau or office library	Number of books circulated								Current periodicals circulated		Number of borrowers
	To individuals		To main library		To branch libraries		Total				
	1929	1930	1929	1930	1929	1930	1929	1930	1929	1930	1930
Main library.....	20,038	21,087	-----	-----	26,768	26,666	46,806	47,753	(1)	(1)	1,223
Agricultural Economics.....	13,802	14,667	1,049	1,060	101	114	14,952	15,841	(1)	(1)	480
Animal Industry.....	2,233	2,667	189	211	124	107	2,546	2,985	31,226	32,296	80
Chemistry and Soils.....	7,785	7,107	1,028	802	87	40	8,900	7,949	37,386	36,870	285
Dairy Industry.....	1,987	2,203	100	80	41	16	2,128	2,299	22,372	26,442	64
Entomology.....	3,004	3,882	652	402	12	15	3,668	4,423	5,759	6,939	175
Experiment Stations.....	² 2,116	2,614	(1)	(1)	(1)	(1)	(1)	2,614	³ 33,502	30,312	102
Forest Service.....	2,230	2,310	498	270	-----	0	2,728	2,780	7,874	9,716	160
Home Economics.....	3,427	3,720	316	368	(1)	0	3,743	4,088	8,124	10,369	71
Plant Industry.....	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	34,504	36,763	(4)
Public Roads.....	2,901	2,727	481	592	(1)	(1)	3,382	3,892	14,233	15,324	146
Total.....	59,523	62,984	4,313	3,785	27,133	26,958	88,853	94,624	194,980	205,031	2,786

¹ Figures not available.² Figures for September, 1927–June, 1928.³ Figures for September, 1927–June, 1928. (In the report for 1929 figures were by mistake given as 53,502.)

⁴ The Bureau of Plant Industry library does not maintain a collection of books, as it is in close proximity to the main library. The circulation of books to members of the bureau is, therefore, included with those for the main library, but circulation figures are available for current periodicals, as this circulation is handled in the Bureau of Plant Industry library.

TABLE 10.—*Books borrowed from other libraries during 1930*

In Washington		Outside of Washington	
Bureau of American Ethnology.....	1	American Museum of Natural History.....	6
Bureau of Education.....	8	Arnold Arboretum.....	3
Bureau of Fisheries.....	12	Boston Medical Library.....	1
Bureau of Mines.....	1	Cornell University.....	2
Bureau of Standards.....	42	Forest Products Laboratory.....	1
Department of Commerce.....	1	Harvard University.....	6
Department of Labor.....	4	Iowa State College.....	4
Department of State.....	2	John Crerar Library.....	3
Geological Survey.....	89	Johns Hopkins University.....	9
Hygienic Laboratory.....	14	Lloyd Library.....	1
Library of Congress.....	4,073	Massachusetts Horticultural Society.....	6
National Museum and Smithsonian.....	60	Mayo Clinic.....	4
Pan American Union.....	1	Merrill-Palmer School.....	1
Patent Office.....	44	Museum of Comparative Zoology.....	5
Public Health Service.....	10	New York State College of Agriculture.....	2
Public Library.....	22	Notre Dame University.....	1
Surgeon General's Office.....	386	Peabody Institute.....	6
United States Army Engineer's School.....	1	University of Chicago.....	4
United States Naval Observatory.....	3	University of Illinois.....	1
War Department—Ordnance.....	1	University of Minnesota.....	2
Weather Bureau.....	49	University of Nebraska.....	2
		University of North Carolina.....	4
		University of Pennsylvania.....	1
		University of Wisconsin.....	3
		Wisconsin State Horticultural Society.....	1
Total.....	4,824	Total.....	79

Average number of books borrowed from other libraries daily.....	16
Average number of books borrowed from other libraries monthly.....	408
Total number of books borrowed from libraries in and outside of Washington.....	4,903

TABLE 11.—*Interlibrary loans outside of Washington, classified by institutions, 1926 to 1930*

Borrowers	1926	1927	1928	1929	1930
Land-grant colleges and experiment stations.....	1,017	1,195	1,421	1,186	1,191
United States Department of Agriculture workers stationed outside of Washington.....	411	461	525	465	505
Colleges and universities other than land-grant colleges.....	124	112	162	242	281
Other scientific institutions.....	210	220	207	228	251
Business firms.....	48	82	82	136	195
Public libraries and miscellaneous.....	43	88	35	73	121
Total.....	1,853	2,158	2,432	2,330	¹ 2,544

¹ In addition to the 2,544 books and periodicals lent to borrowers outside of the city last year, 128 photostatic copies and 36 typed copies of articles were supplied, making a total of 2,708 loans for the year, an increase of 130 as compared with those of 1929.

TABLE 12.—*Interlibrary loans outside of Washington, D. C., 1921-1930*

United States (States, Territories, and island possessions) and foreign countries	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930
United States:										
Eastern—										
Connecticut.....	13	5	5	10	48	53	24	36	24	19
Maine.....	1	-----	1	12	8	1	3	1	10	6
Massachusetts.....	16	34	37	30	62	62	67	92	116	84
New Hampshire.....	9	11	22	12	6	1	21	19	12	13
New Jersey.....	89	63	107	75	92	78	68	106	67	129
New York.....	81	117	101	136	149	158	188	174	175	217
Pennsylvania.....	51	37	35	60	75	65	35	108	97	102
Rhode Island.....	5	8	-----	1	15	18	4	6	8	2
Vermont.....	7	12	11	20	14	19	43	14	46	38
Total.....	272	287	319	356	469	455	453	556	555	610
Central—										
Illinois.....	20	17	13	6	25	44	69	27	56	58
Indiana.....	38	7	32	24	23	41	38	58	25	71
Iowa.....	72	59	69	82	76	13	38	42	23	24
Kansas.....	3	23	15	14	18	11	30	14	14	9
Michigan.....	50	24	41	44	39	40	30	63	46	46
Minnesota.....	88	44	60	59	70	77	62	47	66	48
Missouri.....	6	22	21	30	37	54	32	12	42	43
Nebraska.....	7	7	14	10	25	23	33	26	29	13
North Dakota.....	14	10	8	15	10	15	5	15	6	9
Ohio.....	32	35	32	89	86	139	187	161	143	214
South Dakota.....	-----	3	-----	1	1	-----	1	1	2	1
Wisconsin.....	48	63	35	33	88	67	55	74	63	56
Total.....	378	314	340	407	498	524	580	540	515	592
Southern—										
Alabama.....	17	5	6	8	3	13	11	4	8	19
Arkansas.....	32	21	24	23	20	29	47	51	48	32
Delaware.....	21	28	35	84	103	78	75	63	102	131
Florida.....	5	13	33	73	80	73	134	107	114	104
Georgia.....	12	31	15	14	31	35	43	34	44	52
Kentucky.....	13	30	34	49	23	16	24	8	31	50
Louisiana.....	5	15	15	10	13	17	13	14	65	140
Maryland.....	24	17	66	117	65	115	85	105	137	171
Mississippi.....	4	2	2	5	1	2	18	3	5	3
North Carolina.....	26	43	27	48	61	39	64	40	43	95
Oklahoma.....	7	8	5	1	13	15	40	56	31	61
South Carolina.....	12	11	15	22	20	30	26	34	27	44
Tennessee.....	11	12	33	8	8	7	3	7	3	6
Texas.....	21	14	19	19	3	26	17	18	43	26
Virginia.....	46	28	38	40	52	47	109	48	65	28
West Virginia.....	13	15	13	15	16	30	15	18	12	12
Total.....	269	293	380	536	512	572	724	610	778	974
Western—										
Arizona.....	23	-----	1	11	20	5	20	34	18	6
California.....	16	18	29	52	47	54	53	64	87	63
Colorado.....	18	9	37	13	9	15	39	31	17	12
Idaho.....	1	7	1	4	4	12	24	15	2	32
Montana.....	7	6	38	26	17	25	37	26	33	30
New Mexico.....	11	-----	1	-----	2	2	8	2	-----	-----
Nevada.....	-----	2	1	-----	-----	-----	-----	-----	-----	-----
Oregon.....	53	30	15	6	8	38	35	91	28	31
Utah.....	19	22	12	45	28	57	47	90	43	31
Washington.....	31	4	7	17	22	39	30	33	49	25
Wyoming.....	6	11	3	7	21	3	5	12	8	4
Total.....	185	109	145	181	178	250	298	398	285	234
Territories and island possessions:										
Alaska.....	-----	1	-----	-----	-----	-----	1	-----	1	-----
Canal Zone.....	1	-----	-----	-----	-----	-----	-----	-----	-----	8
Guam.....	-----	-----	-----	-----	-----	1	-----	-----	-----	-----
Hawaii.....	-----	-----	-----	-----	1	-----	-----	-----	1	-----
Porto Rico.....	32	9	9	20	17	22	13	279	115	24
Total.....	33	10	9	20	18	23	14	279	117	32
Foreign countries:										
Canada.....	-----	-----	-----	-----	-----	24	40	44	70	101
Cuba.....	-----	1	-----	-----	-----	-----	3	-----	-----	-----
Other countries.....	2	1	-----	5	12	5	2	5	10	1
Total.....	2	2	-----	5	12	29	45	49	80	102
Grand total.....	1, 139	1, 015	1, 193	1, 505	1, 687	1, 853	2, 114	2, 432	2, 330	2, 544

TABLE 13.—*Statistics of bureau libraries*¹

Bureau or office	Em- ployees	Books	Pam- phlets	Period- icals cur- rently received	Regis- tered bor- rowers	Regis- tered bor- rowers to whom period- icals are circu- lated	Shelv- ing	Area occu- pied by library
	<i>Number</i>	<i>Number</i>	<i>Number</i>	<i>Number</i>	<i>Number</i>	<i>Number</i>	<i>Linear feet</i>	<i>Square feet</i>
Agricultural Economics.....	17	² 57,438	-----	1,827	480	-----	4,365	4,963
Cotton Division.....	1	-----	-----	-----	-----	-----	-----	-----
Animal Industry.....	2	(³)	-----	593	79	80	(³)	540
Animal Husbandry Division.....	1	-----	-----	170	-----	-----	446	630
Chemistry and Soils.....	3	10,753	-----	580	285	165	1,770	1,000
Fertilizer and Fixed Nitrogen Investigations.....	2	-----	-----	-----	-----	-----	(⁴)	(⁴)
Dairy Industry.....	4	680	5,050	384	64	61	180	400
Entomology.....	4	11,388	13,250	1,039	175	42	1,634	1,000
Experiment Stations.....	8	4,138	68,698	1,197	102	62	1,847	1,702
Forest Service.....	1	² 25,764	-----	⁵ 180	160	-----	1,227	1,132
Home Economics.....	1	2,700	(⁴)	299	71	43	782	841
Plant Industry.....	11	(³)	-----	700	(³)	166	140	650
Public Roads.....	4	⁵ 8,205	15,180	488	146	155	1,389	912
Agricultural Engineering.....	⁶ 1	(⁴)	(⁴)	-----	-----	-----	230	256
Solicitor's Office.....	1	-----	-----	-----	-----	-----	-----	-----

¹ The Weather Bureau library is administered separately, with the exception that the books and periodicals are purchased from the appropriation of the library of the department, the sum of \$1,000 being set aside each year for this purpose.

² Includes pamphlets.

³ Does not maintain a collection of books.

⁴ Figures not available.

⁵ Approximate figures.

⁶ Vacant.

TABLE 14.—*Library staff of the department*

Library	Admin- istra- tive posi- tions	Assist- ants	Clerks	Trans- lators	Mes- sengers	Char- women	Total
Main library.....	4	21	3	-----	4	3	35
Bureau and office libraries:							
Agricultural Economics.....	1	12	3	-----	1	-----	17
Cotton Marketing Division.....	-----	1	-----	-----	-----	-----	1
Animal Industry.....	1	1	-----	-----	-----	-----	2
Animal Husbandry Division.....	-----	-----	1	-----	-----	-----	1
Chemistry and Soils.....	1	1	-----	1	-----	-----	3
Fertilizer and Fixed Nitrogen Inves- tigations.....	-----	1	1	-----	-----	-----	2
Dairy Industry.....	1	1	2	-----	-----	-----	4
Entomology.....	1	2	1	-----	-----	-----	4
Bee Culture Division.....	-----	1	-----	-----	-----	-----	1
Experiment Stations.....	1	6	-----	-----	1	-----	8
Forest Service.....	1	-----	-----	-----	-----	-----	1
Home Economics.....	1	-----	-----	-----	-----	-----	1
Plant Industry.....	1	6	3	-----	1	-----	11
Public Roads.....	1	2	1	-----	-----	-----	4
Solicitor's Office.....	-----	-----	1	-----	-----	-----	1
Total.....	10	34	13	1	3	-----	61
Grand total.....	14	55	16	1	7	3	96

TABLE 15.—Financial statement, 1921 to 1930
RECEIPTS

Source:	Fiscal year—									
	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930
Library appropriation—										
Salaries.....	\$32,880.00	\$30,060.00	\$32,660.00	\$32,660.00	\$40,000.00	\$38,680.00	\$54,680.00	\$60,000.00	\$69,100.00	\$69,300.00
General expenses.....	22,000.00	21,400.00	25,000.00	30,000.00	30,960.00	29,500.00	29,500.00	24,180.00	6,580.00	32,700.00
Total.....	54,880.00	51,460.00	57,660.00	62,660.00	70,960.00	68,180.00	84,180.00	84,180.00	95,680.00	102,000.00
From department printing and binding fund.....	7,031.20	14,549.59	7,460.64	10,621.26	13,171.04	9,983.30	13,173.75	10,045.07	8,199.46	10,614.72
Main library salaries paid by bureaus.....	5,221.67	7,560.02	10,472.89	12,257.50	15,117.84	16,521.50				
Grand total.....	67,132.87	73,569.61	75,593.53	85,538.76	99,248.88	94,684.80	97,353.75	94,225.07	103,879.46	112,614.72

EXPENDITURES

Books and serials.....	\$9,439.69	\$9,998.58	\$11,182.48	\$11,138.26	\$13,582.31	\$14,710.31	\$14,750.47	\$13,093.14	\$14,801.18	¹ \$18,689.78
Periodicals.....	6,039.62	6,353.68	7,008.48	6,916.54	6,937.19	7,184.29	7,517.97	8,845.99	9,061.88	9,425.13
Maps.....										
Index cards.....	178.51	141.88	172.45	147.37	162.45	169.30	137.88	155.41	165.75	136.62
Furniture, shelving, and miscellaneous equipment.....	2,525.94	29.91	2,435.20	1,738.15	1,908.83	404.77	476.86	1,133.24	821.04	1,569.37
Traveling expenses.....	219.72	190.23	177.52	971.06			78.44	108.04		29.64
Freight, express, and drayage.....	56.94	62.90	13.95	21.51	44.97	42.29	16.52	12.47	20.00	8.88
Supplies and repairs (itemized below for 1929—1930).....	518.50	566.76	1,459.67	1,136.98	1,015.01	971.84	1,122.24	1,077.00	² 1,349.09	1,671.39
Truck service.....		9.87	52.78	38.89	81.81	85.80	78.87	95.40	107.97	104.12
Newspapers.....			94.16	99.32	97.80	99.60			809.50	963.21
Salaries (statutory).....	27,013.25	30,059.01	32,219.04	31,960.67	39,799.96	38,613.92	54,066.54	59,655.09	68,526.70	69,252.43
Salaries (miscellaneous).....	2,921.35	3,931.62	2,394.35	7,774.99	6,194.51	5,080.00	5,319.96			
Total.....	48,913.52	51,344.44	57,210.08	61,943.74	69,824.84	67,362.12	83,565.75	84,175.78	95,674.39	101,850.57
Printing.....	342.34	1,826.01	579.03	567.97	444.47	477.32	327.96	438.25	553.00	349.43
Binding.....	6,688.86	12,723.58	6,881.61	10,053.29	12,726.57	9,505.38	12,845.79	9,607.82	7,646.46	10,265.29
Main library salaries paid by bureaus.....	5,221.67	7,560.02	10,472.89	12,257.50	15,117.84	16,521.50				
Grand total.....	61,166.39	73,454.05	75,143.61	84,822.50	98,113.72	93,866.92	96,739.50	94,221.85	103,873.85	112,465.29
Credit received for duplicates exchanged with book dealers and libraries.....				954.75	604.35	216.35	653.68	147.30	455.76	335.64
Gifts.....				12.94	10.75					

Supplies		1929	1930	Repairs		1929	1930
Cleaning and toilet supplies.....		\$107.62	\$95.07	Repairs and alterations:			
Stationery.....		208.67	214.74	Carpentry work.....		\$160.74	\$188.13
Miscellaneous office supplies.....		264.74	289.19	Electrical work.....		191.04	241.12
Binding material.....		126.32	109.47	Typewriter repairs.....		27.19	15.43
				Painting.....		186.59	124.30
Total.....		707.35	708.47	Miscellaneous repairs.....		76.18	393.94
				Total.....		641.74	962.92

¹ Outstanding liabilities for books, periodicals, and serials, \$144.43.

REPORT OF THE CHIEF OF THE BUREAU OF PLANT INDUSTRY

UNITED STATES DEPARTMENT OF AGRICULTURE,
BUREAU OF PLANT INDUSTRY,
Washington, D. C., August 30, 1930.

SIR: I have the honor to submit herewith a report of the work of the Bureau of Plant Industry for the fiscal year ended June 30, 1930.

Respectfully,

WM. A. TAYLOR,
Chief of Bureau.

HON. ARTHUR M. HYDE,
Secretary of Agriculture.

WORK AND ORGANIZATION

The Bureau of Plant Industry is a research organization, devoting approximately \$5,000,000 annually to the investigation and improvement of plant production and to the discovery of important facts for plant industries of various kinds. The record of the past year has been of unusual significance. More than ever before it is apparent that further improvement or even continued maintenance of crop production calls for extensive research of the most thorough character. In the production of staple crops and to some extent in other phases of agricultural production, the American farmer is in indirect but none the less actual competition with other agricultural regions throughout the world. Under these circumstances it becomes of the utmost importance that greater efficiency in crop production in this country be steadily developed. Improved cultural practices, the utilization of labor-saving machinery wherever practicable, and, above all, the utilization of the varieties most likely to produce a satisfactory crop in the particular locality under consideration, are as essential for the national well-being as for the immediate success of the individual farmer.

Increased efficiency is desirable not merely for the purpose of increasing production on a given area but also for the purpose of increasing the producer's profit from a given area. Improved cultural methods that will decrease the cost of production must be developed, and improvement in quality of products without material increase in cost of production is essential so that annual returns may increase accordingly. While the interests of the bureau are sufficiently broad in scope to include any phase of plant studies, the primary object of all its activities is efficiency of production. The problems of production are investigated to determine economic gains

from improvements in quality or type of product, to stabilize annual crops through control of losses due to disease, and to develop better methods for storage and distribution of products to insure steady consumption.

Accordingly the bureau is engaged in crop improvement by breeding and selection; in the introduction of new crops by means of seeds and plants procured from foreign countries; in experimentation in methods of culture and rotation systems adapted to irrigation, dry-land farming, and other systems of agriculture; in investigations in handling, storing, shipping, processing, or otherwise utilizing plants or plant products; and in the study, diagnosis, and control of many kinds of plant diseases. Some of the results of the bureau's investigations during the past year are briefly described in the following pages. The scope of the researches is more completely indicated in the appended list of articles issued by specialists of the bureau.

The work of the bureau has been carried on by the following organization:

Office of the Chief-----	William A. Taylor, chief of bureau. K. F. Kellerman, associate chief of bureau.
Arlington Experiment Farm-----	H. E. Allanson, assistant chief of bureau. E. C. Butterfield, senior horticulturist and superintendent in charge.
Barberry Eradication-----	F. C. Meier, principal pathologist, in charge.
Biophysical Laboratory-----	G. N. Collins, principal botanist in charge.
Blister Rust Control-----	S. B. Detwiler, principal pathologist in charge.
Botany-----	F. V. Coville, principal botanist in charge.
Cereal Crops and Diseases-----	M. A. McCall, principal agronomist in charge.
Citrus Canker Eradication-----	Directed by associate chief of bureau.
Cotton, Rubber, and Other Tropical Plants-----	O. F. Cook, principal botanist in charge.
Drug and Related Plants-----	W. W. Stockberger, principal physiologist in charge.
Dry-Land Agriculture-----	E. C. Chilcott, principal agriculturist in charge.
Egyptian Cotton Breeding-----	T. H. Kearney, principal physiologist in charge.
Fiber Plants-----	L. H. Dewey, senior botanist in charge.
Forage Crops and Diseases-----	R. A. Oakley, principal agronomist in charge.
Foreign Plant Introduction-----	K. A. Ryerson, principal horticulturist in charge.
Forest Pathology-----	Haven Metcalf, principal pathologist in charge.
Gardens and Grounds-----	J. W. Byrnes, assistant in charge.
Horticultural Crops and Diseases-----	E. C. Auchter, principal horticulturist in charge.
Mycology and Disease Survey-----	C. L. Shear, principal pathologist in charge.
Nematology-----	N. A. Cobb, principal nematologist in charge.
Phony Peach Eradication-----	Directed by associate chief of bureau.
Seed Laboratory-----	Edgar Brown, principal botanist in charge.
Sugar Plants-----	E. W. Brandes, principal botanist in charge.
Tobacco and Plant Nutrition-----	W. W. Garner, principal physiologist in charge.
Western Irrigation Agriculture-----	C. S. Scofield, principal agriculturist in charge.

FRUITS

APPLES

INJURY IN TRANSIT

Interesting results have been obtained with respect to what has apparently been previously considered in some cases as freezing injury of apples during transit. Certain characteristics evident in frozen apples had come to be considered as convincing proof of injury by that means, but such characteristics had sometimes been observed in fruit that was known not to have been subjected to freezing temperatures. Further studies have developed the fact that when apples are bruised from maintained excessive pressure, the deep watery bruises formerly considered to be caused by freezing are produced. This problem is of particular importance in view of the fact that this type of injury has been observed frequently in boxes of apples on the floor of cars where freezing during periods of critical temperatures in transit was most likely to occur, but it is also in the lower tiers of boxes that the bruising from excessive pressure from the weight of the fruit above is likely to occur.

Quite a different question which has arisen was the possibility of apples affecting the flavor of oatmeal when they were stored together. Carefully conducted tests showed that a decided odor and taste may be imparted to oatmeal from proximity to apples in storage.

PERENNIAL CANCKER

A disease of tree and fruit known as perennial canker, which is causing serious loss in apple orchards in certain of the fruit-growing sections of Washington and Oregon, has been given considerable study. It has apparently been somewhat confused with anthracnose, which is probably more widespread on the Pacific coast than is perennial canker, but less serious from an economic standpoint. Perennial canker frequently infects trees that have suffered winter injury. As that form of injury has been somewhat severe in some parts of the Northwest in recent years, perennial canker has likewise come into prominence to a greater extent than formerly. The nature of this disease, its manner of infection, and other facts concerning its life history are being investigated with a view to working out some effective and practicable method of control.

OIL SPRAYS

Because of the value of oil sprays in the control of certain insects, particularly in the Northwest, and because of the variable results obtained under some conditions from the use of different oils, especially with respect to their injurious effects on the tree, experiments on this subject have been conducted in cooperation with experiment stations in the Northwestern States and in British Columbia and with the Bureau of Entomology and the Bureau of Chemistry and Soils of this department. The work has yielded results to the point where specific recommendations are now being made as to the particular types of oil most suitable for use and as to the precautionary measures that may be observed by orchardists in applying oil sprays with a view to avoiding injury.

AVOCADOS

The pollination of avocado varieties offers many perplexing problems which are being studied by the bureau. The very local adaptation of varieties with regard to pollination has not generally been fully appreciated. Because the blossoms are so sensitive to weather conditions prevailing at the blossoming period, a particular variety may or may not fertilize itself. For instance, the principal variety grown in California, if planted where it is under the influence of the cool sea breezes along the lower coast, is ordinarily self-fruitful, but when planted under some other conditions it is self-unfruitful because of the difference in the opening of the blossoms. This difference may be observed in trees on the opposite slopes of a mesa only a few hundred yards apart. This same variety when grown under Florida conditions requires cross-pollination.

BERRIES

About 85,000 strawberry seedlings of known parentage resulting from hand-made crosses were under observation during the year. One selection, given the name Blakemore, was introduced to the trade during the winter of 1929-30. This variety has attracted attention because of its superior canning and preserving qualities.

A superior blackberry variety has been developed and given the name Brainerd, and is being propagated for introduction.

Preliminary results on the use of different mineral nutrients in the growing of strawberries have been secured. Heavy supplies of nitrogen have stimulated a dense leaf growth, but an undue increase in the density of the foliage was accompanied by an increase in decay of the fruit. Moreover, plants that have developed an excessively dense growth of foliage appear to be more seriously affected by severe drought than plants with healthy but less vigorous leaf growth, presumably because of the greater amount of transpiration from the larger leaf area. The use of potash alone appeared to produce highly acid berries, lacking otherwise in flavor, while phosphorus and nitrogen applied together apparently produced berries of excellent quality.

CITRUS

ORANGES

Certain very promising strains of the Washington Navel orange have been discovered in connection with the bud-selection investigations. These include (1) an early ripening strain in which the fruits mature from four to six weeks earlier than the normal strain, (2) a very prolific strain that appears to be much more productive than the normal strain, and (3) one in which the trees tend to blossom and set fruit over a much longer period than the normal strain.

Further studies of the Wase variety of Satsuma orange have apparently proved its value for commercial culture in the Gulf coast region from New Orleans to Tallahassee. In Japan the tree lacks vigor and productiveness and the skin of the fruit is so tender that it is not valuable for shipping. Under Gulf coast conditions the tree grows well and is fairly productive. Its early season of ripening and high quality give it a place in the Satsuma industry.

The Silverhill variety of the Satsuma group has demonstrated a remarkable degree of cold resistance in comparison with other varieties.

STERILIZING INFESTED FRUIT

One of the most critical and serious problems of the year in fruit handling has been in connection with the Mediterranean fruit-fly infestation in Florida. In working out methods of sterilizing citrus and other fruit that might be under any possible suspicion of exposure to infestation with fruit fly it was necessary to devise methods that would prevent any chance of transportation of living insect eggs or larvæ and that at the same time would not adversely affect the keeping or eating qualities of the fruit.

As a result of much investigational work it was found that the objectives could be accomplished by cooling the fruit to a temperature of 28° F., holding it at that temperature for five hours, and then keeping it for about five days at 30°. Another method consisted in heating the fruit to a temperature of 110° and holding it at that degree for eight hours. Each of these methods has its practical application from the economic standpoint in view of the great volume of fruit that needed to be treated. While adverse results sometimes followed, they seem beyond question to have been due to lack of care in details and to a failure of operators to adhere strictly to specific directions.

CITRUS CANCER ERADICATION

The effectiveness and value of the joint campaign by the Bureau of Plant Industry and the Gulf States for the eradication of citrus canker, a bacterial disease that threatened the citrus industry, are evident from the rapid reduction in the number of infected trees and the thoroughgoing success in preventing epidemics in commercial regions. Conditions seem to indicate that final and complete eradication will be accomplished, although several years of further close inspection will probably be required.

In Florida the disease has been found at various times on 515 properties scattered through 25 counties, but no infection has been reported since November, 1927.

In Alabama 621 properties have been found infected at various times, but no infection has been reported since June, 1927, when one tree was found infected, and at the present time the State is believed to be free from canker.

In 1916 Mississippi had 108 properties in four counties showing infections. In 1922 there were eight infected properties. In 1923 all properties were declared clean, and no infections have been reported since.

Citrus canker has been found in nine counties in Texas, but it is believed that it has now been practically eradicated from that State, as no new infection has been reported since February, 1929.¹

Louisiana is still reporting many scattered infections in dooryard plantings, although the commercial producing regions are free of canker. It will probably be several years before the disease is completely eradicated from that State.

¹ In July, 1930, however, a slight infection was found in a nursery outside the citrus belt.

Each State is now maintaining a close reinspection of all citrus properties, and this will be continued for several years because of the extreme infectiousness of citrus canker.

DATES

Offshoots of certain varieties of dates considered of exceptional potential value for certain regions, but not previously available in the United States, were obtained and shipped to this country in sufficient numbers to permit of testing them in regions where varieties to be successful must possess some rain resistance. These offshoots are becoming established in this country, and it may be expected that in due course important results will be obtained.

The study of the botanical characters of the more than 100 date varieties now grown in this country, undertaken to develop information on the basis of which the identification of varieties in any stage of their growth may be made, is now well advanced. It seems probable that each of these varieties is distinguishable from all the others by the fruit characters alone, by the leaf characters, or by the characters of the stem alone. This study is of great economic value not only because of the ease with which date varieties may become mixed and offshoots of little commercial value substituted for those valued perhaps at \$100 each, but especially because of the importance of using a proper pollinizer with each variety. The pollen used in fertilizing a variety of dates determines to a large degree the time of ripening, size of seed, and size and quality of fruit.

The recent identification of certain Old-World varieties of dates, which have been grown in this country to a very limited extent for some time and the names of which were previously unknown, has great economic significance because of the more favorable response of these varieties in this country than under Old-World conditions.

It was ascertained during the year that the Deglet Noor variety, which is the standard late sort in the Coachella Valley, may hold over its fruit and ripen it in late spring or early summer of the following year when grown in California between the mountains and the ocean. None of the earliest varieties available ripen in this region in advance of the autumn and winter rains. This appears to be a promising solution of the problem of obtaining varieties that will ripen in the coastal region of California.

GRAPES

Economically important and tangible results have followed the testing of recently introduced and little-known varieties of grapes. The dissemination of information derived from critical tests of many such varieties has been followed by extensive commercial plantings of some of them. Recently individual vineyards comprising 5,500 acres in one case, 3,300 acres in another, and more than 2,000 acres in still another, have been planted to some of these newer types, the merits of which had been brought to light in the bureau's vineyard tests. Included among these varieties are Ohanez, Monukka, and Gros Guillaume.

PEACHES

BREEDING

In the breeding of fruits to obtain more desirable varieties, considerable attention is being given to the peach. Some 1,500 seedling trees of known parentage, largely of peaches but including also pears, plums, cherries, and certain other fruits, resulting from hand-made crosses, fruited in 1929. In preliminary studies at least 21 peach crosses were found which give great promise for use in the fresh state, and 12 selections especially desirable for canning.

In the course of bud-selection work, certain bud variations have been located which apparently constitute superior strains of peaches of the canning type and which are regarded as potentially of great economic value. These are a variation in an Ontario peach tree, the variant bearing fruits which ripen from three to four weeks before the normal type, an early ripening variation of the Phillips Cling peach that produces fruit better for canning than the normal Phillips Cling, and an exceptionally heavy and fine-fruited Hauss variation which appears to be much more productive than the normal type.

CANNING STUDIES

In a study of peaches for canning, extending over several seasons, and including a correlation of degree of maturity as determined by the use of the pressure test, the chemical composition of the fruit, and the quality of the canned product, it was found that there is a very close relationship between the temperature and the sunshine during at least the last part of the growing period, and between the chemical composition of the fruit and its rapidity of ripening. The fruit is very susceptible to weather conditions, and both the physical conditions and the chemical composition may change with great rapidity under different conditions, thereby affecting the various qualities of the fruit.

PHONY PEACH ERADICATION

The phony disease of the peach has continued to occupy an important place in the bureau's work, with continued research on the nature of the disease and its method of dissemination and infection. There appears to be no longer any doubt that this trouble is one of the so-called virus diseases. The results of certain experiments started in 1927 indicate that although the effect of the virus is readily apparent in the branches and foliage, the virus itself does not enter the woody tissues but is confined to the bark of the root. The principal object of research with respect to control is to find some stock suitable for peaches which is also resistant to this disease. Since there seems to be no possibility of eliminating the disease from a tree that has become infected, and since an infected tree soon becomes of no commercial value and a menace to other trees, an extensive campaign of eradicating affected trees under expert direction has been inaugurated.

This campaign, which was begun July 1, 1929, by the bureau in cooperation with the States of Georgia and Alabama, has been very

effective during this first year. The enthusiastic aid of peach growers has been secured, and the diseased trees have been destroyed with great rapidity as specialists have identified them. A trained force of inspectors was assigned to this work, and during the year they inspected nearly 12,000,000 peach trees, more than 11,000,000 of which were in Georgia, and of which 87,696 in Georgia, 613 in Alabama, and 139 in Mississippi were definitely diagnosed as having the phony disease. Peach districts have not been adequately surveyed, but slight infections have also been found in Louisiana, Arkansas, and Tennessee.²

From the circumstantial evidence it is clear that the disease began developing first in this country in the vicinity of Fort Valley, Ga., and it is hoped that the eradication campaign can succeed before the disease is transmitted through nursery stock to more northern and western peach-growing areas. The disease affects the trees by causing pronounced dwarfing of both the limbs and the fruit to such an extent that the commercial value of the trees is destroyed, although aside from its slow growth the tree appears to be in good condition. In the Fort Valley district, where the disease has been known for many years, many productive orchards have been completely ruined.

FROZEN PACK

The "frozen pack" of fruits and vegetables, particularly the former, has attracted considerable attention both commercially and as a subject of investigation in the last few years. By this method the fruits are variously packed, frozen quickly in the containers, and held in that condition until desired for use. Some of the berries, particularly the strawberry, have been handled commercially by this method much more extensively than any other fruit. The product is used at soda fountains, in the making of ice cream, and by the restaurant and preserving trades. Within the past year or two much interest has developed in the packing of such material in small containers which are suitable for family use and can be delivered direct to the home. This method of packing presents many problems, including the details of handling the product, the rapidity with which it is frozen, its treatment before it goes into the container, the physical changes that may take place within the container, the bacterial flora and its relation to the keeping of the product and the health of the consumer, the quality and appearance of the product when it is thawed and ready for consumption, and various other factors.

Preliminary results of experiments indicate that all fruits should be packed with sugar to secure good quality. Hermetically sealed containers gave a better product than those which air could enter. Berries in general were very good when packed this way. Peaches were of good quality when removed from the cans, but

² Shortly after the close of the fiscal year scattering infections were also found in North Carolina, South Carolina, and Texas.

Quarantine restrictions were established June 1, 1929, safeguarding the movement of peach nursery stock from infected counties of Georgia and Alabama. Possible extension or modification of this quarantine will be considered at a public hearing held November 14, 1930, by the Plant Quarantine and Control Administration of this department.

darkened quickly. Results with pears, apricots, and sweet cherries were not promising.

NUTS

PECANS

In the investigations dealing with the production of pecans in the Southeastern States, experiments are under way to determine root-stocks best adapted to pecan production, the influence of size and age of nursery stock upon field growth and behavior, and the influence of methods of handling nursery stock upon the field growth. The hybrids now coming into fruiting are being tested.

A 100-acre farm near Shreveport, La., suitably equipped with buildings has been donated to the department by Caddo Parish for pecan investigations, and during the year approximately half the area was planted to pecan trees. These will be utilized in part in pruning tests and in part in nutritional and soil-management studies.

PERSIAN WALNUTS

Extensive studies on the pollination of the Persian walnut have been carried on for the last several years. It has been determined that all varieties so far as tested are inherently self-fertile, but the development of staminate and pistillate flowers at different times on many varieties may actually result in partial or complete self-sterility. This is particularly serious in a practical way with certain late-blossoming varieties. These studies include the recording of the blossoming dates of different varieties under different climatic conditions, thus making it possible to recommend with reasonable assurance particular varieties for planting together with a view to insuring cross-pollination.

VEGETABLES

BEANS

Progress was made in the practical control of a number of serious bean diseases, including blight, anthracnose, mosaic, rust, and bald-head. This has come about in part at least through the development of additional knowledge in regard to the life histories and characteristics of individual disease organisms. One study, stimulated by poor germinating quality of bean seed, brought to light the fact that the trouble was due to the fracturing of the embryo in the seed, caused by the seed striking against the cylinder teeth of the threshing machine or being hurled against the teeth of the concave.

A hitherto unreported fungus disease called scab has been found affecting the Lima bean in Porto Rico and Cuba. Although the disease has been observed on many shipments of commercial Lima beans offered for entry from these islands, it is not yet known to occur in the continental United States. Because of the potential threat to the Lima-bean industry of this country, particular attention has been given to a study of the life history of the causal fungus and the characteristics of the disease. Leaves, stems, and

pods are affected, and when plants are severely diseased the pods may fail to develop. This disease is of economic importance not only because of its ravages in the field but also on account of the conspicuous disfiguration of the pods. The fungus involved is tentatively identified as *Elsinoe canavaliae* Rac., a species previously known only from the Orient on jack beans.

CABBAGE

Two cabbage diseases, yellows and black rot, were given special consideration during the year. A strain of Jersey Wakefield cabbage resistant to yellows was released for increase. Good progress has been made toward selecting resistant strains of several other varieties. It is estimated that in Wisconsin, Ohio, Illinois, and Iowa about 23,000 acres were devoted to cabbage production in 1929 and that a large part of that acreage consisted of yellows-resistant strains resulting from this work. Information concerning the life history and means of spread and infection of black rot was obtained.

CHAYOTES

Increased interest and activity in growing the chayote, a cucurbit vegetable from tropical America, have been evident in the South during the last two years. The chayote is a pear-shaped fall-maturing vegetable fruit of the same family as the cucumber and the squash and is adapted for garden cultivation from South Carolina to eastern Texas and in southern California. Some of the extension workers in Florida have been especially active and successful in stimulating consumption in their respective localities, with the result that for the first time there has been produced a market supply of this valuable introduction for late summer use.

LETTUCE

Breeding work with lettuce is in progress with a view to developing heat-resistant strains adapted to growing in the eastern United States. About 450 seedling lettuce plants selected from more than 2,000 which resulted from handmade crosses between known parents have been grown to the seeding stage for further test. Attention is also given to breeding strains of lettuce resistant to brown blight and mildew, diseases that have seriously handicapped the growing of lettuce in the Southwest. In the fall of 1929 approximately 1,000 breeding plots were planted in the Casa Grande district of Arizona and about 4,000 plots in the Imperial Valley in California. Sixteen lettuce selections which appeared the most promising for commercial use in the 1928-29 breeding plots were increased to the extent of 10 to 30 pounds of seed of each during the summer of 1929. Thus far two strains which are highly resistant to both of the diseases mentioned show outstanding promise of commercial value, and already more or less resistant strains that have been developed in this work have largely superseded the old varieties formerly grown in the Southwest. These strains are not only more resistant to disease than the old sorts, but much more productive.

POTATOES

That the manner in which seed potatoes are handled before planting may greatly influence the yield was demonstrated in an investigation that involved the holding of the seed tubers in cold storage at 36° F. until a short time before planting them, and then, for about 10 days prior to planting, subjecting different lots to temperatures of 40°, 50°, 60°, and 70°, respectively. The yield was greater from seed pieces held at the higher temperature prior to planting and suberized seed resulted in prompter germination and larger yields than did freshly cut potato sets.

In the study of old (that is, early cut and stored) compared with freshly cut sets, it was demonstrated that the former, if properly suberized after cutting and properly stored until planted, yield equally as well as freshly cut seed. The practical significance of this finding is that an extensive grower can cut his seed whenever it is convenient to do so, provided he has proper storage facilities for suberizing and holding it, and not be obliged to delay cutting until he is ready to plant.

In the potato-breeding work certain seedlings have proved highly resistant to mild mosaic disease, and a number of seedlings of Rural New Yorker extraction have shown a high degree of resistance to potato wart. Material progress is recorded in the development of yellow-fleshed varieties better adapted to the climatic conditions of the United States.

The temperature at which freshly dug potatoes are stored immediately after harvest has been shown to have a decided effect on the cooking and table quality of potatoes. Storage at 36° and 40° F. has a decidedly detrimental effect as compared with preliminary storage at 60° to 70°.

TOMATOES

Further progress has been made in the development of tomato varieties of high quality which are highly resistant to some of the diseases that seriously attack the varieties heretofore available. Certain varieties developed by breeding have largely superseded the older varieties in a number of sections. Thus the Marglobe variety, developed in this effort, is not only a superior tomato, but because of disease resistance it has taken the place of practically all other varieties in the tomato industry in Florida, and about 60 per cent of the production on the west coast of Mexico is of this variety: besides, it is being grown extensively in other tomato-growing districts. A number of other varieties of great merit have also been developed.

The investigations of tomato diseases have given a better understanding of their nature and of the means by which they are spread, thus making it possible to avoid some of them, at least in field culture. Studies in Florida have shown that primary infection with tomato mosaic generally occurs in the seed bed. When the seed bed is effectively protected from insects that carry the disease from adjacent host plants, or when such host plants are destroyed, freedom from the disease in the seed bed results.

A virus disease of the tomato known as "streak" has been found to consist of at least three distinct types which can be definitely differentiated. As these forms possess different biological relation-

ships to the host and to their environment, this determination furnishes a definite basis on which each one of the types can be treated.

Further studies of bacterial canker of tomatoes have developed additional facts in regard to the life history of the causal organism and the reaction to its environment, thus making it possible to take into account in field culture certain facts of importance not previously known.

It has been found that the loss from decay of tomatoes in transit from certain districts can be materially reduced by subjecting the fruits for two minutes to a 1-to-300 formalin bath before they are packed.

Tomato blight, another common and serious tomato disease, not readily controlled by spraying or dusting, seems to be effectively held in subjection by the simple expedient of completely burying all crop remains and other dead organic matter lying on the surface of the soil, by plowing in the fall.

TYPE STUDIES OF VARIETIES

Studies of vegetable types are being carried on with peas, tomatoes, and cabbage. This is a cooperative undertaking with various State experiment stations, the object of which is to select the most desirable types of particular varieties of the different vegetables. Then by making full and detailed descriptions and illustrations of each variety it is proposed to establish an accredited type of each as a means of standardizing types and varieties. Vegetable varieties for the most part are grown from seed, and while a well-fixed strain or variety reproduces substantially true from seed, there is more or less variation. Where there is no fixed varietal standard to serve as a guide to the characteristics of a particular variety, each seedsman, making selections from his own stock for further seed production, naturally will establish his own particular type. Thus there may come to be a very wide variation in the product of a particular variety of vegetable when grown from seed obtained from different sources, and yet the variation represented in the product will all have come originally from the same parent stock. With the characteristics that shall constitute varietal types agreed upon by competent authority, and those types adequately recorded, there will exist some recognized standard toward which seedsmen can select in the reserving of seed stocks for propagation.

CANNING EXPERIMENTS

In a study of the factors affecting the canning of vegetables, eight varieties of peas were studied in detail. It was found not only that there are differences in canning quality due to the variety itself, but that the same variety canned at different stages of maturity varies widely. Apparently there is a relationship between chemical composition and specific gravity and the quality of the canned product.

A similar line of work, though with certain divergent aspects, was carried on with beets, kale, Swiss chard, carrots, and sweetpotatoes. These vegetables were all grown under known conditions. During their development various quantities of nitrate of soda were applied, the object being primarily to determine the influence of different

quantities of nitrogen on the chemical composition of the products and their relation to the canning quality. It was found that the application of nitrates results in increasing the accumulation of nitrate in the plant tissues somewhat in proportion to the amount applied. It has also been found that there is a rather definite relationship between the nitrate content of plant tissues and the amount of corrosion of the tin cans used as containers in canning. This explains the fact, commonly recognized, that under some conditions a certain vegetable may cause corrosion, whereas at other times the same vegetable does not corrode the can.

CEREALS

BARLEY

SCAB

Barley scab was less general and less severe in 1929 than in 1928 except in local areas in northern Ohio, Indiana, Illinois, and Iowa, and in eastern Nebraska, southern Wisconsin, and southern Minnesota. The importance of thoroughly removing cornstalks from land to be sown to barley in order to control scab was strikingly shown in Ohio. In the corn-borer clean-up area where cornstalks had been thoroughly plowed under, less than 1 per cent of the barley heads were scabbed. In surrounding areas where clean-up was not practiced, severe epidemics on barley were common, as many as 35 to 45 per cent of the heads frequently being scabbed. Scabbed barley is now principally used for feeding cattle or other ruminants.

SMUT

Plants from seed of Wisconsin Pedigree No. 5 barley, naturally inoculated with loose and covered smut, showed no reduction in covered smut and a large reduction in loose smut when the plants were grown from hulled seed. This suggests that the loose-smut inoculum was carried in the hulls and that the covered-smut inoculum was carried on parts of the seed other than the hull. This is contrary to prevailing belief and is particularly interesting because seed-treatment experiments previously had shown that surface disinfection is effective in controlling covered smut, while loose smut is controlled only by the deeply penetrating modified hot-water seed treatment.

CORN

BREEDING

Hybrids from inbred lines of corn, developed in cooperative experiments with several State experiment stations, continue to demonstrate their superior yielding ability. Various of these strains produced from 10 to 40 per cent more grain than the best local varieties in experiments in South Carolina, Georgia, Louisiana, Missouri, Kansas, Iowa, and Ohio.

In the cooperative experiments with the Ohio station marked differences were found in the response of different strains to manure and fertilizer applications. Three strains producing respective

yields of 30, 30, and 22 bushels when unfertilized, produced respectively 49, 60, and 64 bushels following the application of 16 tons of manure and 800 pounds of commercial fertilizer.

RESISTANCE TO COLD

The degree of cold necessary to produce injury varies widely with different strains of inbred and crossbred corn. Some strains are killed by temperatures several degrees above the freezing point, and other strains are able to stand temperatures several degrees below frost without material injury. With a given strain, cold resistance is more marked on soil of high productivity than on soil of low productivity. This applies to corn both in the seedling stage and during the maturation period. In the seedling period, infection with *Penicillium oxalicum* increased susceptibility to cold injury.

In the maturation period, stalks and shanks injured by cold were more susceptible to attacks of the stalk-rot fungi such as *Gibberella*, *Diplodia*, and *Basisporium*. Cold-resistant strains were more resistant to these fungi and produced not only higher yields but better corn than the cold-susceptible strains. Other things being equal, seed corn from cold-resistant strains produces seedlings more resistant to the seedling blights caused by *Gibberella* and *Diplodia* than are seedlings from seed produced by the cold-susceptible strains.

GRAIN SORGHUMS

IMPROVED VARIETIES

The extra-dwarf straight-neck milo, Beaver, originating from a back cross between Dwarf Yellow milo and a kafir-milo hybrid, continues to gain in popularity with producers. The variety yields slightly less than Dwarf Yellow milo at most experiment stations, but the difference is not great enough to offset the advantages of its dwarf erect character, which permits easy harvesting with a combine or a grain header with very small losses of heads. Certain other selections originating from kafir-milo hybrids appear even more promising than Beaver from the standpoint of yields and apparently are equally satisfactory from the standpoint of machine harvesting.

CULTURAL EXPERIMENTS

An improved method of seed-bed preparation and planting for grain sorghums has been developed in cooperative experiments at Hays, Kans. The soil is listed during late autumn or early winter. When weeds start to grow during April, the ridges are "thrown in." At planting time the old furrows are partly "nosed out" with a lister or with a loose-ground disk planter, leaving sufficient warm moist mellow soil in the bottom of the furrow for a good seed bed. Prevailing farm practice is to plant with a lister planter at the bottom of a freshly made furrow where the soil has had no opportunity to become mellow or warm. The steep sides of the furrows made by the common method allow the soil to wash into the bottom of the furrow with heavy rains, frequently burying the seedlings. The improved method involves little if any more labor than the usual practice and is much more certain to produce good stands.

OATS

NEW VARIETIES

In 221 farm tests during an 11-year period, the Kanota variety, developed in cooperative experiments at the Kansas station, outyielded Red Rustproof by an average of 9.7 bushels per acre. Kanota outyielded Red Rustproof in 192 of the tests. In weight per bushel Kanota was superior to Red Rustproof by an average of 4.8 pounds, a difference consistent with the average over a 9-year period. The superiority of Kanota is probably due to its earlier maturity, which averages about a week earlier than that of Red Rustproof.

Heretofore no known variety of oats has proved resistant to all physiologic forms of crown rust. During the past year two strains introduced from Argentina under the names Victoria and Avena Victoria have proved to be extremely resistant to all forms with which they have been tested, including, among others, the widespread and particularly virulent physiologic form 5. This is a very promising development, since it suggests the possibility of solving the serious problem of loss from crown-rust infection, which is especially severe in certain parts of the South. Crosses involving these new varieties, as well as others that have shown some resistance to crown rust, already have been made in an effort to develop suitable commercial varieties possessing the crown-rust resistance of these sorts.

SMUTS

A continuation of studies on the effect of the oat hull on the incidence of smut in plants grown from unhulled as compared with those grown from hulled seed shows that both loose and covered smut are greatly reduced in amount when the seed is hulled (hulls removed). This shows that the inoculum carried by the hulls is an important factor in infection.

The Markton variety has proved uniformly free from both loose and covered smut under field conditions. When hulled seed of the Markton oat was inoculated with both loose and covered smut before being planted, the resulting emergence was reduced approximately 90 per cent. Seedlings that emerged were noticeably malformed. All plants that matured were free from smut. Markton is evidently highly susceptible to smut during the seedling stage, but is able to outgrow the smut and to produce normal unsmutted heads.

In cooperative experiments at the Washington Agricultural Experiment Station a large number of selections from crosses involving the smut-resistant Markton as one parent have been tested for resistance to covered smut. Seventy-five selections were found to be highly resistant or immune from the smut collection used for inoculation. Two hull-less hybrids have been developed that are immune from covered smut and have yielded 6 per cent more grain than Markton.

RICE

PATNA TYPES

A certain quantity of rice of so-called Patna type is imported into the United States for use in the preparation of commercial canned soups, etc. This rice originates in certain parts of India and Burma.

where it is grown from fall sowings, being harvested very early in the spring. In order to meet, if possible, the demand for such rice with the American-grown product, samples of Patna rice have been sown in Texas, Florida, and Georgia. So far, field-sown material has headed and flowered too late to produce seed in this country.

In controlled experiments conducted at the Arlington Experiment Farm (near Rosslyn, Va.) it has been possible to induce heading and flowering of the Patna rices by subjecting them to a shorter day, comparable to that which occurs naturally during their growing season in the regions where they are commercially produced. These studies, while still somewhat limited in scope, indicate that it may not be possible to grow in this country the Patna rices thus far introduced because of their peculiar adaptation to a shorter day-length than occurs in the American rice-producing area during the growing season. Attempts are now being made to find adapted Patna types and to use such material in breeding adapted varieties that will meet the requirements now filled by the imported commercial Patna.

NITROGEN FERTILIZERS

In pot experiments to determine the ability of the rice plant to use different forms of nitrogen fertilizer, sodium nitrite, sodium nitrate, and ammonium sulphate were added at rates of 100 and 200 parts per million. All three forms of nitrogen gave increased yields, the largest increase being obtained when 200 parts per million of ammonium sulphate were added. The results indicate that the rice plant can use all three forms of nitrogen to good advantage.

WHEAT

IMPROVED VARIETIES

Extensive regional experiments, cooperative with the State agricultural experiment stations in Minnesota, North Dakota, South Dakota, and Montana, showed that in 1929 Reliance and Ceres, the new varieties of hard red-spring wheats, were more widely adapted and gave better yields than other varieties similarly grown. Reliance has shown a high capacity for yield under favorable conditions, particularly under irrigation. The variety is not resistant to stem rust, however, and for that reason should not be distributed where this disease is important. Ceres, bred at the North Dakota station, is somewhat resistant to stem rust and under normal conditions is more widely adaptable than any other hard red-spring variety now available. It is also of satisfactory commercial quality. The Hope variety, developed from a cross of Yaroslav emmer and Marquis wheat, practically immune in the field from stem rust and highly resistant to leaf rust, bunt, and loose smut, is now being produced commercially. In 1929 about 400 acres of Hope were grown, and there has been a substantial increase in 1930.

The smut-resistant variety of hard red winter wheat, Oro, developed in cooperative experiments at Moro, Oreg., has given high yields in Kansas, Nebraska, and Montana. It has strong straw and is of good bread-making quality. The winter of 1928-29 was very severe in southern Minnesota. The Minturki variety, developed in coopera-

tive experiments at the Minnesota station, was given a thorough test. The variety is increasingly popular in southern Minnesota, northern Iowa, and southeastern South Dakota, because of its hardiness and its resistance to bunt and stem rust.

In cooperative experiments at the Cornell (N. Y.) station, red-kerneled selections of soft red winter wheats produced an average of 7.5 bushels per acre more than an equal number of white-kerneled selections. Despite this advantage, the red varieties are less grown than the white wheats in that State, although Forward, an improved red-kerneled variety, developed in the cooperative experiments, is gradually increasing in acreage. A new variety, Wharten, selected from a wheat-rye hybrid at the Arlington Experiment Farm, has outyielded Purplestraw in four of the last five years. This variety is similar to Purplestraw in growth habit, the latter variety being the wheat parent. Wharten shatters and lodges less than many other soft red winter wheats and seems to be well adapted for harvesting with the combine. The Albit variety of white wheat, produced in cooperative experiments at the Washington station, is rapidly increasing in acreage in the State of Washington at the expense of the old standard Hybrid 128. Albit is resistant to the physiologic form of bunt most prevalent in eastern Washington, although it is susceptible to other less prevalent forms.

FOOT ROTS

The take-all disease of wheat is becoming increasingly destructive in Kansas and Oklahoma. In cooperative experiments at the Kansas station in both field and greenhouse the addition of certain organic amendments to the soil has given some control. In the greenhouse the best control was obtained through the addition of alfalfa, sweet-clover leaves and stems, wheat straw, and chicken manure. Horse manure and cow manure gave some control but were less effective than the other organic substances. Inorganic fertilizers gave no control. In the field experiments horse and cow manure gave the best results, although complete control was not obtained from either. In field observations where manure had been applied to part of a take-all infested area, it was noted that no dwarfing of the wheat plants occurred in the manured section and the whitehead symptom was reduced about 65 per cent. No variety of wheat has yet been found that is entirely resistant to take-all, although some varieties are less susceptible than others.

The *Helminthosporium* foot rot of winter wheat again occurred with considerable severity in parts of Montana. Experiments have shown that early sowing favors the development of this disease, and in Colorado, where recommendations based on this fact were followed, the disease was less severe in 1929 than in 1928. In Montana sowing as late as September 12 or later practically controls the disease.

A type of foot rot probably caused by an undetermined species of *Fusarium* was very destructive in 1929 in southern Kansas, northern Oklahoma, and northern Texas. Preliminary experiments are under way, looking to the development of control measures, but have not yet reached a stage justifying recommendation.

An unidentified foot rot occurring in Oregon and Washington proved particularly difficult to cope with. Inorganic fertilizers have no value in controlling the disease. Early sowing favors its development, and late sowing (October 15 or later) seems to inhibit its development. Burning straw on infested areas seems to aid in control. There is a distinct difference in the susceptibility of varieties to the attacks of this foot rot, and studies of varietal resistance are being developed as a possible control.

SCAB

Scab of wheat occurred with considerable severity in several more or less localized areas in 1929. As previously, the heaviest losses occurred where wheat had been sown on unplowed cornland from which the stalks had not been removed. Important losses occurred in Virginia, West Virginia, Missouri, Kansas, and Nebraska. This is the first record of heavy losses from wheat scab in Kansas. Experience in 1929 again emphasized the necessity of removing old cornstalks in order to insure freedom from scab in a following small-grain crop.

Encouraging progress has been made in finding varieties of spring wheat fairly resistant to the head-blight phase of wheat scab. The resistant varieties, Illinois No. 1 and Progress, are being recommended for use in the spring-wheat areas where scab is important. Recognition of the necessity of sowing wheat after some crop other than corn in order to control scab also is gaining headway.

The seedling blight of wheat caused by the scab organism is caused largely through a cortical rot during the early seedling stages. The parasite invades the developing seedling either through natural wounds, such as root ruptures and growth cracks in the epidermal layers, or through mechanical wounds, rather than by direct penetration. Wheat selections that are highly resistant to this blight have been isolated.

SMUT

Cooperative seed-treatment experiments, conducted at 14 stations in 10 States, indicate that, on the whole, copper carbonate is still the most generally satisfactory fungicidal dust for controlling the stinking smut (bunt) of wheat. Copper chloride and copper oxychloride were effective in smut control, but are too corrosive to be recommended for general use in drills. Formaldehyde, used after presoaking the wheat, gave better control of stinking smut than did any of the dusts used, but the presoaking makes the method impracticable.

STEM RUST

Field observations in experimentation cooperative with the Minnesota station in 1929 indicated that urediniospores of stem rust, originating in Texas, were blown northward as far as Fremont, Nebr., on the south winds of May 25 to 28, 1929. Subsequent overlapping spore showers extended the area of infection into Canada. Scant rainfall was probably the major factor in preventing a general serious epidemic of stem rust in the spring-wheat area.

Studies cooperative with the Minnesota station have shown that, in addition to morphologic and physiologic resistance to stem rust, there is also a resistance which may be termed functional. A study of wheat varieties has shown that there is a wide variation in the response of the stomata, or breathing pores, to the influence of light. The stomata of certain very susceptible varieties open very shortly after sunrise, while dew is still present on the plants. Spores of *Puccinia graminis* can germinate and infection tubes can grow only when dew is present. Infection occurs only through the open stomata, and the opening of the stomata while dew is present offers opportunity for infection. It was observed in certain highly-resistant varieties that stomata do not open until some considerable time after sunrise, and that opening is not only more delayed, but that the stomatal openings remain as mere slits for some considerable period. This delay may be long enough to afford opportunity for the drying up of the dew before infection can occur.

BARBERRY ERADICATION TO CONTROL STEM RUST

The barberry-eradication campaign, begun in 1918, is aiding in the reduction of losses from stem rust of wheat, as the common barberry and certain closely related species and varieties are the only known alternate hosts for this fungus and are the only known sources of local inoculum in the 13 States comprising the barberry-eradication area. Although observations indicate that during certain seasons rust spores may be carried by the wind from the South into the spring-wheat area, this wind-blown infection seldom, if ever, reaches the Northern States in time to produce serious epidemics, and the early infection can generally be traced to near-by barberry bushes.

The most reliable indication that barberry eradication is materially aiding in the control of stem rust is the noticeable reduction in the number of local outbreaks of rust in the areas where most of the barberry bushes have been destroyed.

In 1929, on 1,630 properties, 551,685 barberry bushes, sprouting bushes and seedlings were destroyed. Of this number 100,836 bushes and sprouting bushes on 647 properties had escaped from cultivation and were located in wood lots and along ditches, fence rows, and river bottoms. Since 1918 more than 18,143,000 common barberry bushes and seedlings have been destroyed. Salt and kerosene were used as killing agents.

During the field season of 1929 two severe local epidemics of stem rust were traced to common barberry bushes in North Dakota. Other stem-rust spreads of minor importance were traceable to barberry bushes in a number of spring-wheat States. In Minnesota alone 25 cases were observed and recorded.

The policy followed in selecting territory for survey during the field season of 1930 varied somewhat from that of previous years. (1) An emergency plan was formulated to give immediate relief to as many grain growers as possible by promptly attempting to locate the source of rust infection, following reports of rust received from property owners or county extension agents. (2) The regular organized survey work is being conducted with the idea of increasing

activities for the immediate future in the principal spring-grain-growing States, and at the same time giving preference to those areas in each State where the production of small grains is important. (3) Attention is being given to locations where fruiting bushes are known to exist, with the idea of preventing further dissemination of seeds.

FORAGE CROPS

ALFALFA

SOURCE OF SEED

The importance to American agriculture of the source of alfalfa seed has warranted not only the continuance but the extension of the trials with seed from different sources. The results show that the same variety or seed from the same source can not be used wherever alfalfa is grown and that it is necessary to use judgment in selecting the suitable strain. For example, Ladak has outyielded other varieties in the northern Great Plains, where lack of moisture is a limiting factor, and under irrigation in the northern intermountain area, but it has not proved satisfactory in the humid East. There Ontario Variegated or Grimm are the varieties giving best results. Of the common alfalfas, seed produced in the Northern States has proved most cold resistant, while that from Kansas and Utah has given good results in the southern two-thirds of the United States and elsewhere where winter conditions are not too severe. The southern strains of alfalfa can safely be grown only in the extreme South and Southwest. Hairy Peruvian has suffered severely at Stoneville, Miss. Turkestan alfalfas in general are cold resistant and have proved satisfactory in cold, dry climates, but under humid conditions they are short lived. They have commanded renewed attention because of the apparent resistance to bacterial wilt shown by some stocks of Turkestan origin.

Observations of this character prompted the sending of a specialist to Turkestan and Russia in order that seed of known origin might be obtained. As a result of this expedition more than 300 lots of seed have been procured and will be tested for wilt resistance as well as for other desirable qualities.

BACTERIAL WILT

The situation with regard to bacterial wilt of alfalfa continues to be serious, and much attention has been devoted to a solution of this problem. Certain phases of the pathology of this disease have been adequately studied, and efforts are being concentrated on the problem of rapidly determining the resistance to wilt of strains or individual alfalfa plants. One of the most hopeful lines of work is that directed toward the finding or developing of a strain of alfalfa highly resistant to wilt. The work so far done has shown that such resistance is a fact. It remains to develop rapid and accurate methods for determining the degree of resistance, and with such methods to select and propagate resistant strains.

The incidence of bacterial wilt is known to be closely connected with winter injury, which may occur even though no killing results, and which causes cracks in the crown and upper parts of the alfalfa

root. These cracks afford means by which the wilt organism enters. It was therefore considered important to study the relative resistance of alfalfa varieties to cold. Although this study has not been completed, it has developed the fact that varieties that survive best under severe conditions in the field also survive best when subjected to artificial cold.

RED CLOVER

IMPORTED SEED

Imports of red-clover seed have fallen off, but the interest in the value of imported seed continues. In this case, too, the results depend largely on the severity of the winter and on favorable summer conditions. While in 1928 the results of trials with nearly all imported red-clover seed were unfavorable, those made in 1929 were much more satisfactory. At the cooperative station at Ames, Iowa, the yields of hay of all "import" lots of red-clover seed from France were 91 per cent of the average from all American seed and 80 per cent of that from the better American strains. The winter of 1928-29 was very favorable for clover, and when French clover survives it produces well. At the same station the average yield from 17 "import" lots from Poland was 87 per cent of all American strains. The record thus shows that under favorable winter conditions the French red-clover seed gives good yields, but not so good as those from locally adapted seed.

DOMESTIC STRAINS

Preliminary results reported previously indicate that there are strain differences in domestic red clover; in other words, that there is a possibility of selecting a higher yielding red clover than the present common run of clover. In 1929 an effort was made to locate old strains, with the result that seed was secured from more than 60 old stocks, some of them having been grown on the same farm for 20 to 49 years. One strain from Kentucky has already shown outstanding value for that section.

LESPEDEZA

For many years Lespedeza has been making its way north with little help, but gradually spreading each year. It has been known as a valuable pasture plant, and the introduction by the department of two improved varieties has stimulated interest in the crop, especially in the States between latitudes 35° and 40° north and west to Kansas. In 1929 several million pounds of seed of the improved varieties was produced, and the supply is not yet equal to the demand.

SOYBEANS

During the past year a specialist has been in the Orient studying soybeans and soybean products. More than 2,100 lots of seed have so far been sent to the department, and 190 kinds of soybean products have been studied and samples obtained. A study is being made of the variations in oil and protein content in different varieties, with a view to selecting higher producing sorts. During the season of 1929, 230 such selections were made, the selections ranging in

protein content from 32.8 to 43 per cent, and in oil content from 12 to more than 23 per cent.

In field plantings of early, medium, and late maturing varieties of soybeans made at regular intervals through the growing season over a period of years, the time of flowering of plantings on a given date varied considerably from year to year, depending on the prevailing temperature. The mean midsummer temperature at Washington seems to be approximately optimal for all varieties, and the low temperatures of spring and fall tend to delay flowering. Despite the yearly fluctuations, very definite trends in duration of the preflowering stage with advance of season are shown in all varieties. In the greenhouse, with an approximately constant mean summer temperature prevailing, over a period of about six months of the year when the day length did not exceed 12 hours all varieties flowered in about the same number of days and all behaved as early varieties. With increase in day length in spring there was a striking selective action on time of flowering in the different varieties, the latest variety being the first to carry over to fall before flowering. In tests with a fixed day length but varying temperatures, all varieties were delayed in about the same degree by low temperatures, there being no selective action. It appears, therefore, that length of day rather than temperature is responsible for differences in time of flowering of early and late varieties.

SORGHUMS

The sorghums are so important in dry-land agriculture that work is carried on with these crops at Hays, Kans., Woodward, Okla., and Chillicothe, Tex. At these stations breeding and selection work has been pushed, and an important outcome has been a steady increase in the uniformity of sorghum crops in the southern Great Plains region. Through cooperation with the State agricultural experiment stations the results of the selection work have been made available as seed of improved varieties. From the Chillicothe station alone 19,000 pounds of seed of improved varieties was distributed during the year. A similar distribution was made by the Kansas station from the substation at Hays. This distribution of improved varieties developed as a result of the cooperative experimental work has been of great benefit to the agriculture of the region.

PASTURES

About one-half of all forage consumed by cattle in the United States is taken from pastures and ranges, but as a rule the pasture is on the poorest land, and little attention is paid to its improvement. Pasture investigations are expensive and time-consuming. Several years are required to round out sound studies on these problems, but a start has been made, in cooperation with other bureaus in the Department of Agriculture and with State experiment stations, in laying out six experimental pastures. In all these studies results are being measured by animal gains.

SEED-VITALITY INVESTIGATIONS

The study of various laboratory methods of testing seeds for germination has been continued. While it is possible to estimate the plant-producing power of a sample of seed on the basis of laboratory

tests if continually checked with soil tests, the soil test appears to be the only reliable reference method. In a study of the use of chemical forcing agents as compared with soil tests of Canada bluegrass and bentgrass seeds, it was found that certain forcing agents gave results comparable with soil tests and required much less time. A microchemical study was made of the seed coats of alfalfa and red clover to determine the cause of hardness of seed. A study of the effect of various nitrogen compounds on the germination of Canada bluegrass indicates that it is the nitrogen in the compounds which has a hastening effect on germination. Encouraging preliminary results have been obtained in a study of the effect of various gases in comparison with chemical forcing agents.

ENFORCEMENT OF THE FEDERAL SEED ACT

IMPORTED SEED

Samples of 1,403 lots of imported seed subject to the Federal seed act were drawn by the customs service and submitted to the seed laboratories for examination as to purity, weed-seed content, presence of dodder, germination, and origin. Of this seed, 27,250,000 pounds was permitted entry, and 1,000,000 pounds not fit for seeding purposes within the meaning of the act was prohibited entry. Approximately one-half of the seed rejected was red clover; smaller quantities of crimson and alsike clovers, winter rape, timothy, hairy vetch, orchard grass, white clover, and Canada bluegrass were rejected.

The total importations of seeds subject to the Federal seed act in the fiscal year 1930 were 60 per cent of the average imports for the preceding 10 years. There was a marked reduction in the imports of red-clover and hairy-vetch seed as compared with imports the previous year, and a 50 per cent increase in alsike. The imports of crimson-clover, white-clover, rape, and ryegrass seeds were approximately the same for the two years. Only about 333,300 pounds of alfalfa seed, mostly from Argentina, was imported, as compared with a 10-year average of 6,500,000 pounds.

Moisture tests of both hairy-vetch and ryegrass seed show that practically all importations with low germination had a high moisture content. It is therefore important that importers make moisture content one of the conditions of contracts to buy.

MISBRANDED SEED

During the year calls came from Virginia, North Carolina, and South Carolina for protection against the shipment into those States of misbranded agricultural seed. A representative of the bureau's Seed Laboratory, in collaboration with the State departments of agriculture, visited the greater number of seedsmen in Virginia and North Carolina to acquaint them with the extent to which western-grown rye misbranded as Abruzzi rye was being shipped into those States and the relation of the Federal seed act to such shipments. In accordance with the provisions of section 6 of the Federal seed act, seizures were directed and proceedings recommended in the case of the following lots of misbranded seeds shipped in interstate commerce: Misbranded as to origin, six lots of red clover; misbranded

as to purity, one lot of alfalfa, one lot of oats, and one lot of red clover; misbranded as to germination, one lot of alfalfa and two lots of soybeans; misbranded as to both purity and germination, two lots of alfalfa.

FIBER PLANTS

COTTON

COOPERATIVE PRODUCTION

Community cooperation in the production of a single superior variety of cotton is an important means of improving quality and establishing uniformity of product and thereby obtaining better prices. Cooperative undertakings for such improvement are in progress in many communities of the cotton-growing States, and such local efforts are given every possible encouragement by the bureau.

BREEDING AND SELECTION

In the breeding and selection of cotton varieties the development of improved methods is being carried forward to give better assurance of maintaining the uniformity and productiveness of superior varieties and also of preserving the adaptive characters which render it possible for some varieties to produce good crops under a wide range of conditions. Experiments have shown that breeding and selection of a superior variety should not be limited to a single locality or district but preferably should include the entire range of conditions to which the variety is adapted. The need of such precautions is shown by the fact that strains of the same variety which have appeared to be of equal value and productiveness in some of the tests have behaved quite differently under other conditions. Some of the strains showed their ability to continue growth and fruiting under conditions that resulted in definite checking of other strains, leaving no doubt that differences of adaptation existed, although such differences had not been indicated in the localities with the more favorable conditions.

Many experiments with the Texas big-boll varieties have been made in the Southeastern States, with the general result of showing that extra-large bolls often are definitely disadvantageous under the climatic conditions of that region. In periods of damp weather the large bolls open more slowly, take longer to dry out between showers, and are mildewed and rotted more frequently, and the germination of the seed often is very low. The heavy, compact foliage of the big-boll type of cotton also contributes to the dampness and rotting of the bolls. These handicaps in the use of big-boll varieties are a further reason for growing sea-island or other long-staple cotton, especially in the coast districts.

SEA-ISLAND COTTON

Intensive studies of the possibilities of restoring the production of sea-island cotton under boll-weevil conditions in the Southeastern States have been conducted by the bureau for several years on the islands near Charleston, S. C. The work has been in cooperation with the Agricultural Society of South Carolina, but more recently

the experiments have had the interest and cooperation of American cotton manufacturers who formerly used the sea-island fiber and are anxious to have the production of this superior cotton reestablished if possible.

Favorable results were obtained in 1929 with a field planting of sea-island cotton on Wadmalaw Island, S. C., and the experiments are being extended in 1930 to include several plantings in favorable localities on the mainland in Florida. The experiments thus far have indicated that it may be possible to reestablish the sea-island industry in the southeastern districts, if separate communities can be organized to grow the sea-island cotton exclusively and to work out the necessary arrangements with the manufacturers in order to obtain a satisfactory return. Proximity to upland cotton greatly increases the dangers of boll-weevil injury and also the danger of mixing and mongrelizing of the seed stocks.

METAXENIA

Metaxenia, or immediate effect of pollen on the mother plant, has been found to occur in cotton, as a result of experiments suggested by the recent discovery of metaxenia in the date palm by specialists of the bureau. The metaxenia effects so far observed in cotton have been in the direction to be expected from the characters of the several varieties. When applied to flowers of Pima Egyptian cotton, pollen of the short-linted, smooth-seeded Hopi cotton shortened the lint and reduced the quantity of fuzz on the Pima seeds. When applied to flowers of Durango upland, pollen of the late-maturing, long-linted Pima variety retarded the development of the boll and increased the length of the lint.

These findings are not entirely without practical significance. The observed effects, to be sure, are small, yet when they occur they tend to lessen the uniformity of the product. In localities where two types of cotton having very different lengths of fiber are grown in close proximity, as is the case in the Salt River Valley in Arizona, where both Pima and upland cottons are produced, more or less natural cross-pollination takes place. It has been demonstrated that the effect of metaxenia is to shorten the lint on seeds resulting from cross-fertilization with pollen of a shorter-linted type of cotton, and to lengthen it on seeds cross-fertilized by pollen of a longer-linted type. In both cases, therefore, a loss of uniformity results.

EFFECTS OF STRESS ON FIBER QUALITY

In cooperation with the Bureau of Agricultural Economics, investigations are being made of the effects of different conditions of production upon the quality and textile value of cotton fiber. Injuries to cotton fiber from stress conditions in the fields are a limiting factor of profitable production in some of the irrigated valleys, being greatest where cotton is grown on heavy lands and exposed to periods of very high temperature. The need of separating the stress-injured cotton from the normal well-developed fiber is being shown, and is practically feasible because the damage to the plants in the field is readily perceptible, even before picking, so that careful buyers can protect themselves to a great extent by simple field

inspections. Not only is the fiber shorter and weaker in the stress-damaged cotton, but the leaves are wilted, the buds and young bolls are blasted, the older bolls stunted, and many of the seeds are aborted.

ROOT DEVELOPMENT AFFECTED BY IRRIGATION

Conditions of cotton production in the irrigated districts not only are different from those of the rainfall regions, but include a very wide range of conditions which occasion many special problems. A tendency to apply too much water to cotton early in the season has often to be resisted in the interest of obtaining a larger yield and an earlier maturity of the crop. A notably different behavior of the roots was observed following early irrigation of cotton in the San Joaquin Valley in California in contrast with an adjacent planting which was not irrigated till after flowering. The cotton that was irrigated early in the season produced only superficial roots, while the cotton that was not irrigated before flowering formed very long deep roots and showed less distress in dry periods later in the season. The advantages of deferred irrigation had been recognized by previous experience, and this observation on root behavior presents an explanation.

HABITS OF ROOT-ROT FUNGUS

The discovery of sclerotia or hold-over bodies in the cotton root-rot fungus, *Phymatotrichum omnivorum* Shear, was announced in 1929. The sclerotia were observed for the first time in laboratory cultures of the fungus in Arizona, and later they were found under field conditions in Texas. Further studies during 1930 confirm the indications that the formation of sclerotia is a general habit of the fungus, that the sclerotia often are deep-seated in the soil, and that they are not confined to the proximity of roots, since mycelium of the fungus is able to penetrate for distances of 2 to 3 feet from any food materials. Thus it is shown that any effective treatment to eradicate root rot must be of such a nature as to disinfect or modify the character of the subsoil as well as the surface layer reached by tillage. The discovery of the sclerotia undoubtedly will aid greatly in the study of measures of protection against the fungus and in avoiding the danger of spreading it to new localities. Tests are being made of the viability of the sclerotia under various conditions, for different periods of time, and with different fungicide treatments.

PANAMA ABACÁ

A shipment of 1,045 pounds of abacá (Manila hemp) fiber obtained from plants procured by the department in the Philippines in 1925 and established in Panama was made to one of the larger American cordage mills. This fiber was spun into yarn, and this yarn was laid in a 2-inch rope. The fiber, yarn, and rope were tested in the usual manner in the research laboratory of this mill, and the fiber was found to be substantially equal to Manila grade E, and the strength of the rope was a little better than ordinarily obtained in that particular grade and size. These tests appear to disprove the theory that abacá fiber of satisfactory quality can not be produced from plants grown in the American Tropics.

HEMP

In 1929 three selected varieties of hemp—Michigan Early, Chinamington, and Simple Leaf—were grown in comparison with unselected common Kentucky seed near Juneau, Wis. Each of the varieties had been developed by 10 years or more of selection from the progeny of individual plants. The yields of fiber per acre were as follows: Simple Leaf, 360 pounds; Michigan Early, 694 pounds; Chinamington, 1,054 pounds; common Kentucky, 680 pounds. All hemp yields were low in Wisconsin in 1929 because of the abnormally dry season. The Michigan Early was harvested and spread for retting August 3—16 days before the others were ready for harvest. The excellent showing of the Michigan Early for earliness without lowering the yield, and of Chinamington for greater yield, gives practical proof of the value of systematic selection.

SUGAR PLANTS

BEETS

CULTURE AND BREEDING

Large yields of sugar-beet seed of satisfactory germinating quality were again obtained from both commercial and experimental beet planting in the Las Cruces area in New Mexico, where a crop of seed was grown from the undisturbed overwintering stecklings (seed mothers). Yields upward of 3,900 pounds of clean seed to the acre have been grown under experimental conditions. Yields approximating the average yields in the best sugar-beet seed countries of Europe have been obtained by commercial growers using the methods developed in these experiments.

Under severe curly-top conditions, beets spaced 6 inches apart outyielded the standard 12-inch spaced beets of the same age, and otherwise grown under the same conditions, by 3.55 tons to the acre and produced 1,055 pounds more sugar per acre. A selective thinning practice by which as many as possible of the large vigorous seedlings were retained at approximately the desired spacing, and the weak or diseased seedlings were eliminated, was productive of striking increase in tonnage. The large beet plants outyielded the small beet plants by 2.35 tons of beets and 730 pounds of sugar to the acre.

In experiments to develop improved rapid methods of breeding the normally biennial sugar beet, a crop of sugar-beet seed was produced in which the shortest time from seed to seed was a period of 68 days when beet plants were grown during the summer months in Michigan under continuous light in the greenhouse. A similar test conducted in the winter months was productive of even better results, both as to number of plants producing seed and also with regard to the shorter time required, which for the quickest maturing plant was 66 days.

DISEASES

Control of sugar-beet leaf spot by dusting with a protective copper dust, which gives the practical equivalent of Bordeaux mixture, has proved of definite value in large-scale applications. The industry

has been quick to utilize the findings, and in 1929 more than 600 acres were dusted with profit.

Mass-selection methods have been successful in producing seed in quantity of lines of sugar beets resistant to leaf spot and curly top. Where former methods disregarded the disease factor, present work has shown that the disease-resistance factors can be combined with maintenance of quality and yield.

Breeding work in sugar beets has been hampered in the past by lack of requisite basic breeding material of satisfactory quality. Pure-line material, highly resistant to leaf spot, has now been produced by plant-breeding work, and certain selections from wild beets have proved to be practically immune to curly top.

CANE

The value of the mosaic-tolerating P. O. J. varieties of sugarcane introduced by the department is indicated by the production in Louisiana of 199,609 short tons of sugar in 1929 from 155,446 acres planted to these varieties, as compared with the production of only 47,000 short tons in 1926 from 128,000 acres planted to the old mosaic-susceptible varieties which were grown at that time. The superiority of the results afforded by the new varieties both as plant cane and as stubble cane crops has been fully demonstrated; but the development of other new disease-resisting varieties capable of affording yields more nearly comparable with yields obtained in other sugar-producing countries is of the utmost importance, and the breeding of seedling varieties has been continued, approximately 60,000 seedlings having been produced during the 1929-30 season.

Comparative tests of other imported varieties and of numerous seedlings previously produced by the department have demonstrated the superior value of two new disease-resisting varieties. Each of these, one of which is a seedling produced by the department and the other an imported variety, has given increased yields of cane per acre and has afforded indicated yields of sugar per acre varying from 500 to 1,500 pounds greater than the yields of the P. O. J. varieties now grown commercially. Both of these varieties were released for commercial planting in 1930.

Most of the disease-resisting varieties of cane collected as a result of the department's sugarcane exploration expedition to New Guinea in 1928 have successfully passed the quarantine period, and 95 of them are now growing at the breeding station in Florida and will be utilized in the breeding and development of varieties more suitable for culture in the United States.

The new very large species of wild sugarcane, *Saccharum robustum*, discovered in New Guinea, is included in the varieties now at Canal Point, Fla., and it is hoped that the plants will produce flowers suitable for crossing in the fall of 1930. It is believed that the "nobilization" (that is, crossing back with commercial varieties rich in sugar) of *S. robustum* will result in seedlings superior to those obtained by nobilization of the small wild species, *S. spontaneum*, which has been the basis for most sugarcane improvement by breeding during the last two decades.

TOBACCO

ELEMENTS NEEDED IN FERTILIZER

More than half of the tobacco crop is grown on sandy and sandy-loam soils which as a whole are comparatively low in natural plant-food supply. This applies to such elements as calcium, magnesium, and sulphur, as well as to the three primary elements commonly regarded as furnishing a complete fertilizer. Recent investigations indicate that current conceptions of a complete fertilizer for tobacco on these soils must be considerably modified. It is now recognized that a considerable proportion of the light tobacco soils are deficient in magnesia and that this element must be supplied if best results are to be had. It has been discovered also that some of these soils are incapable of supplying sufficient calcium to meet the needs of the tobacco crop. Again, it has been observed that growth may be delayed in some cases, especially in the early stages of development, when no sulphur is added to the soil. Finally, chlorine must be regarded as capable of playing an important rôle in the nutrition of the plant, especially in affording protection against drought. An excess of chlorine, on the other hand, may be distinctly injurious to the crop. Field tests have shown that on the light soils in question highly concentrated fertilizers supplying only the three elements nitrogen, phosphorus, and potassium are likely to give unsatisfactory results unless one or more of the above-mentioned secondary elements are also added to the soil.

CROP-ROTATION EXPERIMENTS

Cooperative experiments conducted at the Caroline County substation of the Virginia Agricultural Experiment Station have given somewhat different results with the so-called sun-cured tobacco, which is a dark air-cured product, from those obtained with other types of tobacco grown on lighter soils. One of the outstanding results is that except when a well-balanced fertilizer is used or legumes are grown the physical state of the soil has become so poor that there are few days in the year on which the land can be satisfactorily prepared or cultivated. Lime has produced decidedly beneficial results in improving the condition of the soil and increasing the value of the crops, except in the case of potatoes. Yields of small grains have been better after potatoes than after corn, and they are also better after potatoes than after tobacco, provided the land is kept free of weeds and grass after the potatoes are harvested. Small grains have given decidedly better yields after tobacco than after corn. Of the legumes used, hairy vetch has given best results, especially for corn, with cowpeas showing next best results. Mixed grasses in the rotation have improved the physical condition of the soil but nevertheless have reduced rather than increased the yields of other crops.

DRUG AND OIL PLANTS

The demand for information on the culture, commercial value, and properties of miscellaneous plants not generally included among the staple farm crops continues. From both urban and rural sections come requests about plants reported to afford opportunities

for profit. There has been a special tendency during the past year to consider the growing of sunflowers, mint, and wormseed, all of which are already produced to the full extent of market requirements. In such cases it has frequently been necessary to discourage further acreage of such crops by emphasizing that overproduction is certain to result. The exploitation of the public's interest in special crops has led during recent years to questionable practices in connection with the sale of ginseng and goldenseal seed, and to afford prospective buyers some measure of protection against unwarranted charges for such seed the bureau issued a statement to the press showing the normal prices charged by reputable growers and setting forth the limitations of such crops.

DRUG-PLANT SURVEY

The flora of the United States includes many plants that are of commercial importance on account of their medicinal properties, and the collection and marketing of such plants constitutes a considerable industry. Information on their distribution and particularly their occurrence in quantity is rather meager, and under normal conditions domestic sources are left largely undeveloped, because many such plants are available cheaply from foreign countries. Recognizing that in certain emergencies this country may have to depend on its own supply of such plants, the National Research Council a number of years ago appointed a subcommittee on pharmacognosy and pharmaceutical botany, in its division of biology and agriculture, to make a survey of the distribution of native medicinal plants and map the areas in which those of most importance may be obtained in quantity. Through its representation on this committee this bureau has largely directed and prosecuted this work during the past two years. Several hundred botanists were requested to list the occurrence of medicinal plants in the regions familiar to them, while specialists of the bureau made field surveys of the New England States and the district comprising the Appalachian Mountain system as far south as northern Georgia, which region furnishes most of these plants for the market. A great deal of information has thus been gathered which will later be assembled for publication, supplemented by sectional maps for ready reference.

INSECT FLOWERS

The tendency to replace arsenicals with plant insecticides has continued to stimulate interest in the possibilities of a wider application of insect-flower (*Chrysanthemum cinerariaefolium*) extract as a garden and field insecticide, with the natural result that the feasibility of the domestic production of the flowers is receiving increasing consideration. Recent results of the investigations under way indicate (1) that a larger yield of flowers than has previously been obtained may result from closer planting; (2) that a modified grain harvester may perhaps be used to harvest the crop and that closer planting will facilitate this; and (3) that the flowers and stems in the form in which they would be obtained by harvesting machines may, when dry, be successfully threshed with a modified grain thresher and the marketable portions separated. Observations of

the crop under local conditions point to the probability that it is well adapted to large-scale farming under irrigation, because under such conditions the maximum yield of flowers is made more certain by control of the moisture and because labor-saving machinery is most advantageously used on large level tracts.

SAFFLOWER AND HEMP

The introduction of new noncompetitive crops into American agriculture at this time is very desirable, and if such crops furnish materials which at present have to be imported wholly or in part they merit special consideration. This country produces large quantities of vegetable oils of the nondrying type, useful in the manufacture of food products and soap, but an inadequate supply of drying oils required in the manufacture of paints, varnishes, linoleum, and related products. Safflower and hemp, yielding valuable drying oils, are oilseed crops that have been under investigation for several years with encouraging results. During the past year slightly over 100 acres of safflower were grown under dry-land farming in the small-grain areas of the northern Plains States, with yields ranging from 5.6 to 31.9 bushels per acre, while 9 acres grown under irrigation in Colorado, Idaho, and Utah yielded from 16 to 53 bushels an acre.

Several low-growing types of hemp were grown in small test plots in South Dakota, but owing to adverse weather conditions no reliable indication of their seed-yielding qualities was obtained. It was observed that the crop is less resistant to drought but somewhat more resistant to frost than safflower. The short straw that characterizes these types make it possible to handle them with the usual harvesting and threshing equipment, the tall varieties previously tested having been discarded on account of the difficulty experienced in this respect.

RUBBER PLANTS

BRANCHING HABITS OF HEVEA

Specialized branching habits have been discovered in the Hevea or Para rubber tree of Brazil (*Hevea brasiliensis*), the principal commercial species, and are of a nature to explain some of the difficulties that have been encountered in the efforts to increase the production of rubber from plantations of this tree. The specialization in branching is somewhat like that of the mango tree and the cacao tree, with a normally simple primary upright which often attains a height of 15 to 20 feet before any branches are formed. The growth of the primary upright marks the juvenile stage of the tree and is not continued into the adult stage after the branches are formed. Usually the upright is terminated abruptly by the formation of a compact cluster or whorl of branches, though the number of branches in a whorl is not regular. Adventitious roots are produced spontaneously near the base of the trunk. Cuttings made from the primary upright are rooted or marcotted readily, but many attempts to root cuttings of branches have been reported as complete failures.

AFRICAN RUBBERTREE

The African rubber tree (*Funtumia elastica*) is one of the species that has grown at the United States Plant Introduction Garden at Chapman Field south of Miami, Fla. Flowering has occurred previously, but the first seed pods of *Funtumia* developed recently. The *Funtumia* tree is indigenous in Africa, its distribution extending in the wild state across the tropical belt of the continent, from East Africa to the Guinea coast. That the tree grows well at the Chapman Field garden is a further indication that conditions in southern Florida are essentially tropical. Even if grown only as an ornamental, the *Funtumia* tree may be of interest and value in southern Florida on account of its heavy deep-green foliage, somewhat like that of the coffee tree, but attaining a much larger size.

A DESERT PLANT

A rubber-producing plant (*Euphorbia intisy*) which is highly specialized for desert conditions was introduced from southern Madagascar in 1928 and is being propagated from cuttings, though special treatment apparently is required, as many of the cuttings have failed to root. No material is available for distribution, but the behavior of the plant is being tested at field stations of the department in California and Florida. A study has been made of the anatomy of the tree, including numerous specialized features such as the formation of large fusiform water-storage swellings below the surface of the ground. The proportions of a small tree are attained under favorable conditions in nature, but the rate of growth remains to be determined and may be too slow for a commercial cultivation to be profitable.

ORNAMENTAL PLANTS

BULBS

In ornamental horticulture many important facts in bulb culture and handling, both with respect to cultural features and disease control, have been brought out by the bureau's investigations, and some of these results have been published. The forcing merits of certain flowering bulbous plants not ordinarily grown under glass have been demonstrated. Considerable information of practical value in regard to storage temperatures and storage conditions with respect to their effect on the subsequent performance of the bulbs has been accumulated.

One of the by-products of the bulb-storage investigations was the fact that at certain temperatures the blossoming period of narcissus bulbs was considerably advanced. However, the temperature that seemingly gave the best control for basal rot of narcissus bulbs was not that which gave the most satisfactory results from the cultural standpoint.

A destructive root-rot disease of the calla lily, not previously recorded in the United States, was first found here in 1928. Later studies have indicated the persistence of the causal fungus of the disease in the soil. Preliminary tests indicate that disinfecting the soil with acetic acid, combined with the disinfection of planting stock, affords partial control.

CHRYSANTHEMUMS

In the further development of early flowering hardy chrysanthemums, some 14,000 seedlings from the seed of the previous year were grown the past season, and about 300 selections from this number were reserved for further study. Previous selections have been rigidly culled.

ROSES

In studies of rose stocks it was found that hybrid tea roses budded on *Rosa multiflora* stocks made a somewhat heavier growth and were more productive than those on four other stocks tested. It has also been shown that the quality of Manetti rose stocks may be greatly affected by the manner in which they are handled. For instance, it was found that stocks dug early in the fall made a very poor growth response as compared with similiar stocks dug later in the fall, after they had fully matured.

NURSERY-STOCK STORAGE

The cold storage of dormant trees and shrubs for late spring shipment has been continued. During the year 443 cold-storage shipments were made from the bureau's garden at Chico, Calif., and 256 from the garden at Glenndale, Md. The plants were first packed for shipment in the usual way and then placed in storage at a temperature of 30° to 34° F.

A careful check-up of these shipments, as well as of about 500 such shipments made during the previous season, indicates that with few exceptions thoroughly dormant plants can be held in this way at least six to eight weeks, to be shipped across the continent (which involves a period of 7 to 10 days), and arrive in first-class condition, with little if any growth. Plants in which the buds have swollen can be held at the above temperature and shipped for shorter distances, but for the best results the plants should be placed in cold storage when thoroughly dormant and should be held as near 32° F. as possible.

FOREST-TREE DISEASES

PHOMOPSIS CANKER OF DOUGLAS FIR

Phomopsis canker of Douglas fir, caused by the fungus *Phomopsis pseudotsugae*, was first observed in Scotland in 1913 but was not studied there until after the World War. During the last seven years a specialist of the bureau has studied the disease intensively in Great Britain. There it has proved to be essentially a disease of nursery stock and young planting stock, and while locally destructive and troublesome it has not developed the characters of a major epidemic.

This Phomopsis canker was not found in the United States until 1930, when it appeared in Rhode Island in an isolated 20-year-old plantation of blue Douglas fir, supposed to have been raised in this country. The cankers were few in number and occurred only on lower suppressed branches. The disease at this place presented none of the signs of an epidemic, and in Great Britain blue Douglas fir has been very resistant to this disease. If introduced to the

Pacific coast on green Douglas fir, the disease might assume a most dangerous epidemic form. All cankers found in the Rhode Island plantation have been destroyed, and the plantation is under constant surveillance.

In April, 1930, reports were received of the outbreak of a canker disease of native green Douglas fir in Napa County, Calif. Upon first examination this disease appeared indistinguishable from the *Phomopsis* canker of Great Britain. Later studies, however, indicate that while the general symptoms are the same the causal fungus is another (and probably undescribed) species of *Phomopsis*. This disease has been present in California at least since 1924, but in 1929 there was apparently a sudden increase in its incidence. This may possibly be explained by the exceptional weather. In general, the disease appears to attack the trees that are growing under the most unfavorable conditions. While the causal fungus may have been introduced, it gives the impression of being indigenous, and the disease does not appear to be behaving like a major epidemic. However, it must be kept under observation and investigation for a term of years, to make certain that it does not seriously threaten the immensely valuable stands of Douglas fir in the Pacific Northwest.

EUROPEAN LARCH CANKER

During the last two years the bureau has been engaged in a study of the European larch canker, in order to prevent the general spread of this disease, and in cooperation with States concerned it has undertaken the destruction of diseased trees so far as possible. In the spring of 1927 the disease was discovered at Hamilton, Mass., on imported European larches which had been growing in that locality for about 20 years. Much scouting has been done, but so far the disease has been found in relatively few places, and it probably occurs only where it has been brought in upon diseased nursery stock. As yet it has not been reported outside of Massachusetts and Rhode Island. In addition to being found on European larch, it has been found on Japanese larch and tamarack. This disease, or one so like it that it has not yet been clearly distinguished, also occurs on Douglas fir, western yellow pine, and Scotch pine. All trees definitely known to be diseased were destroyed, in most cases by the owners. This disease is potentially of great economic importance, as it is capable of infecting Douglas fir and western yellow pine and therefore in all probability would cause serious losses in the regions in which these trees form a considerable proportion of the merchantable lumber if by any accident it should be transported from its present scattering infections to these western areas.

DUTCH ELM DISEASE

The Dutch elm disease was not found in this country until June, 1930, when a specialist of the Ohio Agricultural Experiment Station isolated the causative fungus from four wilting trees of American elm at Cleveland, Ohio, and from one at Cincinnati, Ohio. The disease was first observed in the Netherlands in 1919 and has since been found in England, France, Belgium, Germany, Austria, and Norway. It is caused by a fungus, *Graphium ulmi*, which develops principally in the sapwood of affected parts of the tree.

Wilting and dying of the leaves of one or more branches or of the entire tree, together with the presence of dark streaks in the sapwood, constitute the characteristic field symptoms. The disease strikingly resembles the well-known *Verticillium* wilt of maple. The affected trees sometimes die quickly, but usually last for two or three years after the first wilting is observed.

WHITE-PINE BLISTER RUST

The white-pine blister rust, which was introduced from Europe into the Northeastern United States about 1898 and into the Northwest 10 to 15 years later, has spread extensively by periodic waves in the native white-pine forests of these regions. During 1910 to 1928 the rust spread from British Columbia southward through the coastal and Cascade Mountain regions of Washington and Oregon into the northern limits of sugar pine in Oregon. In 1929 infection on *Ribes* (alternate host plants of this disease) was found in Oregon within 50 miles of the California border, indicating that the sugar-pine forests of southern Oregon and California will become infected within a few years. This will necessitate the application of control measures on areas where it is desired to grow sugar pine. Experimental local control, conducted by the bureau in the sugar-pine region of California for the past several years, indicates that such control work can be done at reasonable cost.

In 1929 the rust was found to be generally distributed throughout the principal western white-pine belt of the so-called Inland Empire (western Montana, northern Idaho, and northeastern Washington). Numerous infected pines were found in Clearwater and Shoshone Counties, Idaho, in the heart of the southern portion of the commercial white-pine belt. These infections indicate that the initial infection of *Ribes* from which they resulted took place in 1923. The number and location of these pine-infection centers indicates that an epidemic condition now exists in northern Idaho, and in the course of a very few years damage of great volume and severity may be expected from this destructive disease.

In New England and New York blister-rust damage is steadily increasing in the unprotected areas. Since 1918 approximately 8,000,000 acres of pineland in the Northeastern States have been cleared of *Ribes* at a cost averaging less than 5 cents per acre per year. Recent studies show that this control work is over 90 per cent effective; that is, losses on protected areas are less than one-tenth of the losses on unprotected areas. Continued application of control measures should entirely eliminate losses in this region.

In Michigan, Wisconsin, Minnesota, and Pennsylvania new centers of infection are found on pine and *Ribes* each year. The damage to white pine in these States is certain to increase unless protective measures are applied on a large enough scale to bring the disease under general control.

The bureau is cooperating with the Forest Service and the National Park Service in the protection of valuable white pine on the national forests and parks. In the East control work has been done on the Allegheny, Shenandoah, Monongahela, and White Mountain National Forests and on Acadia National Park. In this work 244,617 wild *Ribes* plants were destroyed on 9,667 acres of pineland. In the

West similar activities have been started on Mount Rainier National Park, and preliminary control work has been done on several of the national forests of Idaho, Montana, Oregon, Washington, and California. Plans are being made for control of the rust on the other national parks and forests where the white and sugar pines are of importance.

DRY-LAND AGRICULTURE

The investigations in dry-land agriculture have shown that in most sections of the Great Plains the agriculture may be developed along either one of two types—industrialized agriculture or mixed agriculture—or by a combination of both. The conditions of dry farming are particularly favorable to the industrialized type of agriculture. The basic crops may be wheat or other small grains, flax, beans, corn, grain sorghums, or cotton, the choice depending upon location and market conditions. The summer fallow is an important item in this type of farming. It eliminates weeds, stores water, prepares the seed bed, and allows an economical use of machinery and distribution of labor. The development of new types of machinery has reduced the cost of the fallow and increased its effectiveness. The investigations of the department and cooperating agencies have shown that deep plowing or deep tillage is not essential to the successful growth of the common field crops, and that annual plowing frequently can be dispensed with. This materially lowers the cost of production.

The other type—mixed agriculture—is based on the growth of feed crops and their rotation with wheat or other grain or cash crops. The principal feed crops are intertilled, and their cultivation prepares a good and cheap seed bed for following crops. Livestock is necessary to utilize the feed crops. This diversifies the agriculture and adds to its stability. Native sod or cultivated pastures can be utilized with this system.

The Northern Great Plains Field Station, Mandan, N. Dak., is a typical dry-land agriculture station in this region. Pasturing experiments conducted for 15 years at this station in cooperation with the State agricultural experiment station have shown that a 2-year-old steer requires about 7 acres of native sod pasture to make the maximum summer gain without damaging the pasture by overgrazing, but that this acreage can be reduced to 5 by a system of deferred and rotation grazing. A combination of cultivated and native pastures has proved more productive than either one alone.

Cultural tests of fruits at this station have shown the value of selecting sheltered sites for horticultural plantings. They have also demonstrated the value of standard spacing or open planting as compared with close planting and of light as compared with heavy pruning. Good fruit can be grown in the home fruit garden when a suitable site is chosen, hardy varieties planted, and proper cultural methods employed.

Arboricultural investigations carried on at this station with approximately 3,000,000 trees used to plant 3,000 shelter belts on farms, 2,100 of which are now growing satisfactorily, demonstrate that groves of trees can be successfully grown for the protection of farm buildings, orchards, and gardens when suitable species are

selected and proper methods of preparing the land, planting the trees, and caring for them are carried out. Investigations to determine the hardiness of different species of trees have been carried on at Mandan since 1915 with approximately 100 varieties planted in pure stands.

All species of willow and poplar with the exception of northwest poplar have been found to be unable to survive the climatic conditions. Species that have given evidence of making a satisfactory growth under the prevailing conditions are caragana, green ash, boxelder, white elm, Chinese elm, chokecherry, native plum, buffalo berry, Russian olive, northwest poplar, Tartarian maple, Black Hills spruce, Colorado blue spruce, Scotch pine, western yellow pine, jack pine, and red cedar.

Cooperative experiments with farmers have shown that hardwood seedlings from 12 to 24 inches high are more satisfactory planting stock than larger sizes. Severe pruning has been found detrimental to growth in height and survival of trees in dry-land plantings. Trees that are closely spaced make greater height growth at first, but after 6 to 8 years a greater growth is made in wider spacings. Summer-fallow the year before planting is an important factor in establishing a stand of trees on dry land.

IRRIGATION AGRICULTURE

CROPS FOR SOIL IMPROVEMENT

It has long been recognized that the arid and semiarid soils of the West are often deficient in humus and that this element must be added to the soil from time to time if its productivity is to be maintained. The results over a series of years have shown that this condition may be corrected by the application of stable manure. Unfortunately, however, the limited amount of livestock on most of the reclamation projects furnishes only a small percentage of the amount required if crop yields are to be maintained. Experiments with alfalfa and to a lesser extent with sweetclover have shown that almost as good results may be obtained with these crops as with manure. The demonstration of this fact, together with the shortage of manure, has resulted in the production of large acreages of alfalfa and sweetclover. This, however, caused the farmers to be confronted with a new problem, that of disposing of these crops.

To meet this situation the bureau has actively fostered cooperative investigations relating to problems of crop utilization by means of livestock. It has become apparent that no single phase of livestock production like dairying would completely fill the need, because not all farmers are inclined to handle or are proficient in handling any one kind of livestock. Consequently different phases of livestock production have been investigated, including dairying, hog, sheep, and poultry raising, lamb feeding, and the fattening of beef cattle. The information made available as a result of these investigations has materially stimulated livestock production, which has resulted in a definite increase in the alfalfa and sweetclover acreages, which, in turn, has had a favorable effect on crop yields. It has been demonstrated that if alfalfa and sweetclover are pastured and properly

managed, they contribute direct returns as well as the indirect benefits. Not only has it been shown that alfalfa may be advantageously marketed through livestock by pasturing, but also that the effect on succeeding crop yields following these practices is often greater than when either alfalfa or manure is incorporated in rotations.

THE SALT PROBLEM

In a number of irrigated areas of the West the irrigation waters contain such large quantities of dissolved salts that precautions are necessary to prevent the accumulation of harmful concentrations of salt in the soil solution of the irrigated land. Investigations conducted for several years have shown that in order to prevent serious salt injury it is essential to obtain information concerning the quantities of salt carried to the land by the irrigation water and the quantities removed by the drainage waters. In this connection it is becoming apparent that in the drainage of irrigated land it is important to have in view not only preventing the accumulation of subsoil water but also preventing the accumulation of salt. On certain irrigated projects it is evident that this condition is approaching an acute stage, to the extent that it is seriously impairing the productivity of the lands.

THE BORON PROBLEM

Substantial progress has been made in determining the extent of occurrence and the concentration of boron in the irrigation waters of the Southwest. The sources of the boron contamination in certain areas have been located and appropriate action for eliminating or reducing injury from these sources have been recommended. It has been found that the salts of boron occur in concentrations that are injurious to crops in the irrigation waters of two areas in the San Joaquin Valley and in one area in the Sacramento Valley not hitherto known. Survey work to determine the sources and limits of contamination has been in progress during the year. Field observations and physiological investigations have shown that there are wide differences among the species of orchard and field crops with respect to boron tolerance. These results indicate that it may be possible to utilize even high-boron waters in the production of a selected group of crops. Furthermore, it has been shown that with occasional leaching of the root zone it is possible to avoid injurious accumulation of boron in the soil solution.

PUBLICATIONS

Articles and department publications written by workers in the Bureau of Plant Industry and issued during the year ended June 30, 1930:

FRUITS

Adjusting orchard practices to meet market requirements. Peninsula Hort. Soc. Trans. 1929: 60-71.
Budding for beginners. Natl. Hort. Mag. 8: 138, 140, 142-143.
Root stock practices and tendencies in Europe. Pacific Rural Press 118: 32-33.
Orchards and vineyards of the future. Better Fruit 24 (5): 5-6, 20.

Practical methods of preventing losses in orchard management. Tenn. State Hort. Soc. Proc. 24: 31-34.
Relation of leaf area to size and quality of apples and pears. Amer. Soc. Hort. Sci. Proc. (1929) 26: 160-162. (With Wash. Agr. Exp. Sta.)
Fruit cleaning methods and their efficiency. Oreg. State Hort. Soc. 42d Ann. Meeting, Ann. Rpt. (1927) 19: 55-68.

APPLE

- A physiological study of rooting and cal-
lusing in apple and willow. Jour. Agr.
Research 39: 81-128.
- What determines the type of soil manage-
ment, fertilization, and pruning that
apple orchards should receive. Mich.
State Hort. Soc. Ann. Rpt. 59: 136-144.
- Factors affecting size and color develop-
ment of apples. N. Y. State Hort. Soc.
Proc. 75: 88-95.
- Some factors influencing the growth of
apple seedlings. Amer. Soc. Hort. Sci.
Proc. (1929) 26: 74-76.
- A large apple tree. Fruits and Gardens.
27 (9): 6.
- Apple industry of Japan founded on Ameri-
can varieties. U. S. Dept. Agr. Yearbook
(1929) 1930: 117-119.
- Effect of the apple strain of the crown-gall
organism on root production. Jour. Agr.
Research 40: 747-753.
- The tendency of the crown-gall organism
to produce roots in conjunction with tu-
mors. Jour. Agr. Research 39: 747-766.
- Aerial crown gall of the apple. Jour. Agr.
Research 39: 249-262.
- The wholly-knot type of crown gall. Jour.
Agr. Research 39: 427-450.
- Fungicides for apples—control versus in-
jury. Ark. State Hort. Soc. Proc. (1929)
50: 38-40.
- Changes in the pectic constituents of apples
in relation to softening. Jour. Agr. Re-
search 39: 739-746.

AVOCADO

- Pollen sterility in the Collinson avocado.
Jour. Heredity 21: 35-38.

BERRIES

- Small fruit breeding investigations of the
United States Department of Agricul-
ture. N. Y. State Fruit Testing Co-op.
Assoc. Inc. Rpt. 1929: 13-16.
- Changes in the rate of respiration of the
fruits of the cultivated blueberry during
ripening. Science 70: 15.
- Some things that may be done within the
next few years to adjust ourselves to
the false blossom situation. Amer. Cran-
berry Growers' Assoc. Proc. (1929) 60:
10-15.
- Life history and pathological aspects of
Godronia cassandrae Peck (Fusicoccum
putrefaciens Shear) on cranberry. Phy-
topathology 19: 1017-1024.
- Respiration of cranberry plants in rela-
tion to water injury. Amer. Cranberry
Growers' Assoc. Proc. (1929) 60: 10-15.
- Preliminary report on a variety of red cur-
rant resistant to Weymouth pine rust.
Bot. Soc. Edinb. Trans. and Proc.
(1928/29) 30 (2): 137-146.
- The Young dewberry. Fruits and Gardens
27 (9): 7.
- Thornless sports of the Young dewberry.
Jour. Heredity 20: 567-569.
- Effect of light, temperature, and transpi-
ration on elongation of canes of raspberry
and other brambles. Amer. Soc. Hort.
Sci. Proc. (1929) 26: 308-311.
- Factors influencing the profitable produc-
tion of strawberries and raspberries.
Md. State Hort. Soc. Rpt. (1929) 31:
205-214.
- Fruit-bud development in strawberry varie-
ties and species. Jour. Agr. Research
40: 393-407.
- Inflorescence types of strawberry varieties.
Amer. Jour. Bot. 16: 571-585.
- Development of runners and runner plants
in the strawberry. U. S. Dept. Agr.
Tech. Bul. 122.

- The Blakemore strawberry. U. S. Dept.
Agr. Circ. 93.
- Strawberry called the Blakemore is a good
dual-purpose variety. U. S. Dept. Agr.
Yearbook (1929) 1930: 497-499.
- Fruit-bud formation in everbearing straw-
berries. Jour. Agr. Research 40: 409-
416.

CHERRY

- Notes on root stocks for Prunus tomentosa.
Amer. Soc. Hort. Sci. Proc. (1929) 26:
77-79.

CITRUS

- Correct horticultural names of citrus fruits.
Citrus Indus. 10 (10): 4-5, 28-29. Also
in Fla. State Hort. Soc. Proc. 1929:
138-144.
- Pruning citrus trees. Valley Farmer 3
(6): 10, 35.
- Injuries and rots that may follow the use
of gasses in the coloring of Florida citrus
fruit. Fla. State Hort. Soc. Proc. 1929:
184-191.
- Infection of fruit of citrus by Pseudomonas
citri. Jour. Agr. Research 39: 403-426.
- Insects as possible carriers of the citrus-
scab fungus. Phytopathology 20: 345-
351.
- Cooperative citrus bud selection. Calif.
Citrogr. 14: 405.
- Progeny plantings for the improvement of
citrus varieties. Calif. Citrogr. 15: 105,
114.
- Bud selection in the Washington Naval
orange progeny tests of limb variations.
U. S. Dept. Agr. Tech. Bul. 123.
- The esthetic side of orange growing in the
Southwest. Calif. Citrogr. 15: 4-5, 33.
- The Jaffa orange industry of Palestine.
Calif. Citrogr. 15: 53, 90-95.

DATE

- Pollination experiments in 1927. Date
Growers' Inst. Ann. Rpt. (1928) 5: 5-7.
- Relative moisture and ash content of green
and partially dry palm leaves. Date
Growers' Inst. Ann. Rpt. 6: 3-4.
- A bud variation in the Deglet Noor date
palm. Jour. Heredity 21: 164-165.
- A sectorial mutation of a Deglet Noor date
palm. Jour. Heredity 21: 157-163.
- Date culture in southern Morocco, espe-
cially the methods and tools used in
pruning the leaf spines preparatory to
pollination. Date Growers' Inst. Ann.
Rpt. 6: 16-19.

GRAPE

- Testing phylloxera-resistant grape stocks
in the vinifera regions of the United
States. U. S. Dept. Agr. Tech. Bul. 146.
- The handling of California table grapes.
U. S. Dept. Agr. Circ. 83.
- Raisin industry in Transjordan and
Palestine. Pacific Rural Press 119: 30.
- Vineyards of Transjordan. Natl. Hort.
Mag. 9: 60-62.

JUJUBE

- How to use the Chinese jujube. Pacific
Rural Press 118: 290.

PAPAYA

- Papaya growing in South Florida has made
some headway. U. S. Dept. Agr. Year-
book (1929) 1930: 400-402.

PEACH

- Control of peach bacterial spot. Md. Agr.
Soc. Rpt. 1929: 221-226. Also in Ga.
State Hort. Soc. Proc. (1929) 53: 32-35.

The phony disease of the peach. Agr. Bul. 1930 (1): 15-19.
Sulphur-spray residues and the swelling of tin cans packed with peaches. Jour. Agr. Research 39: 31-40.

NUTS

PECAN

Pecan pollination and breeding investigations by the United States Department of Agriculture. Natl. Pecan Growers' Assoc. Proc. (1927/28) 27: 144-145.
Importance of studying root behavior of trees. Tenn. State Hort. Soc. Proc. 24: 75-77.
The nutrition of the pecan. Ga.-Fla. Pecan Growers' Assoc. Proc. 24: 46-52.
Comments on the variety situation in Texas. Tex. Pecan Growers' Assoc. Proc. (1927) 7: 16-17.
Report of the Committee on the elimination of pecan varieties. Natl. Pecan Growers' Assoc. Proc. (1927/28) 27: 112-122.
Pecan root observations and their relation to cultural practice. Natl. Pecan Growers' Assoc. Proc. (1927/28) 27: 130-135.
The pecan leaf-blotch. Ga.-Fla. Pecan Growers' Assoc. Proc. (1929) 23: 10-11.
Pecan leaf blotch. Jour. Agr. Research 40: 777-789.
How growers are meeting the pecan scab situation. Natl. Pecan Growers' Assoc. Proc. (1927/28) 27: 106, 108, 110.

VEGETABLES

The first year's work upon standards and descriptions of American varieties of vegetables. Amer. Soc. Hort. Sci. Proc. (1929) 26: 123-127.
Standardizing and describing variety types of vegetables—A nation-wide program. Florists' Exch. 72 (2): 11.
Vegetable variety type book studies. Market Growers' Jour. 45: 509.
Greenhouse mosaic control. Wis. Hort. 20: 61-62.

BEAN

Thresher injury a cause of baldhead in beans. Jour. Agr. Research 40: 371-384.

CRUCIFERS

Clubroot of crucifers. U. S. Dept. Agr. Tech. Bul. 181.
Inheritance of Fusarium resistance in cabbage. Jour. Agr. Research 40: 721-745. (With Wis. Univ. Col. Agr.)

CUCURBITS

Growing cucumbers for pickling. U. S. Dept. Agr. Farmers' Bul. 1620.
Bacterial leaf spot of squash. Jour. Agr. Research 40: 385-391.

LETTUCE

Lettuce growing. U. S. Dept. Agr. Farmers' Bul. 1609.

ONION

Chemical aspects of disease resistance in the onion. Natl. Acad. Sci. Proc. 15: 845-850. (With Univ. Wis.)
Further observations on the occurrence of protocatechuic acid in pigmented onion scales and its relation to disease resistance in the onion. Jour. Biol. Chem. 84: 719-725. (With Univ. Wis.)
The relation of protocatechuic acid to disease resistance in the onion. Phytopathology 20: 431-438. (With Univ. Wis.)

POTATO

An historical résumé of the development of the potato since its discovery. Potato Assoc. Amer. Proc. (1920/30) 16: 7-55.
Report of the Research committee. Potato Assoc. Amer. Proc. (1928) 15: 262-271.
Report of Research committee. Potato Assoc. Amer. Proc. (1929/30) 16: 186-188.
A Solanum hybrid resulting from a cross between *S. fendleri* and *S. chacoense*. Jour. Heredity 20: 391-394.
Breeding and related subjects. Potato Assoc. Amer. Proc. (1928) 15: 297-301.
Report on potato breeding in 1929. Potato Assoc. Amer. Proc. (1929/30) 16: 190-194.
The tuber index method of seed potato improvement. Potato Assoc. Amer. Proc. (1928) 15: 138-140.
Crop rotations and potato profits. Nebr. State Bd. Agr. Ann. Rpt. 1929: 624-630.
Studies in time and rate of irrigating potatoes in Colorado. U. S. Dept. Agr. Tech. Bul. 118.
Potato yields per acre can be much increased with economic efficiency. U. S. Dept. Agr. Yearbook (1929) 1930: 420-423.
Effect of different storage temperatures on the vitality of seed potatoes. Potato Assoc. Amer. Proc. (1928) 15: 12-14. Also in Amer. Potato Jour. 6: 291-293.
Influence of freezing of seed potatoes on viability and yield. U. S. Dept. Agr. Tech. Bul. 119.
Report on potato disease research in 1929. Part of report of Research committee. Potato Assoc. Amer. Proc. (1929/30) 16: 196-200.
Disinfecting seed potatoes. U. S. Dept. Agr. Misc. Pub. 53.
Fungus diseases of potatoes. Potato Assoc. Amer. Proc. (1928) 15: 285-290.
Effect of seed-potato treatment on yield and Rhizoctonia in northeastern Maine from 1925 to 1928. Phytopathology 20: 47-64. (With Fla. and Maine Agr. Exp. Stas.)
Seed potato treatments for Rhizoctonia conducted in northeastern Maine from 1925 to 1928. Potato Assoc. Amer. Proc. (1928) 15: 102-112. With Fla. and Maine Agr. Exp. Stas.)
Potato virus diseases. Potato Assoc. Amer. Proc. (1928) 15: 293-296.
Recent potato virus-disease information contributing to the production of better seed potatoes. Potato Assoc. Amer. Proc. (1928) 15: 203-227. (With Maine Agr. Exp. Sta.)
A pathological feature of flea-beetle injury of potato tubers. Jour. Agr. Research 39: 807-815.
The potato barometer. Amer. Produce Grower 4(12): 6.
The 1929 potato outlook. Amer. Potato Jour. 6: 114-115.
The potato outlook. Amer. Potato Jour. 6: 360-361.

SPINACH

The transmission of cucumber mosaic to spinach. Phytopathology 20: 103-105.

SWEET CORN

Effects of defoliation and root pruning on the chemical composition of sweet-corn kernels. Jour. Agr. Research 40: 575-583.

SWEETPOTATO

Masking of sweet-potato mosaic. Phytopathology 19: 933-942.

TOMATO

- A fruit spot of tomato caused by *Aplanobacter michiganense*. (Note) *Phytopathology* 19:690.
- Changes in the composition of the tomato plant accompanying different stages of yellows. *Plant Physiol.* 5:157-165 (With Univ. Calif.)

STORAGE AND TRANSPORTATION OF PERISHABLES

- Precooling apparatus devised for handling carloads of perishables. *U. S. Dept. Agr. Yearbook* (1929) 1930:430-432.
- Freezing of fruits and vegetables requires more research. *Food Indus.* 2:162-164.
- Storage rots and their control. *Oreg. State Hort. Soc., 42d Ann. Meeting, Ann. Rpt.* (1927) 19:87-95.
- Effect of fertilizers on storage qualities of apples. *Amer. Soc. Hort. Sci. Proc.* (1929) 26:180-181. (With Wash. State Col. Agr.)
- Internal breakdown of apples. *Idaho State Hort. Assoc. Proc.* (1929) 34:12-13.
- A method of testing the keeping quality of certain small fruits. *Phytopathology* 19:593-596.
- The barrelling and freezing of berries. *Oreg. State Hort. Soc. 42d Ann. Meeting Ann. Rpt.* (1927) 19:28-35.
- The frozen-pack method of preserving berries in the Pacific Northwest. *U. S. Dept. Agr. Tech. Bul.* 148. (With Food, Drug, and Insecticide Admin.)
- Storage rots of cranberries in the 1928 crop. *Phytopathology* 19:1037-1039.
- A comparison of average storage temperatures for Early Black and Howe cranberries in Massachusetts. *Wareham (Mass.) Courier* 39 (12):6.
- The probable keeping quality of Early Blacks in Wareham and Carver this season. *Wareham (Mass.) Courier* 38 (45):6.
- The preparation of citrus fruit for export. *Fla. State Hort. Soc. Proc.* 1929:133-137. Also in *Citrus Indus.* 10 (7):8-9.
- Relation of picking time to acetaldehyde content and core breakdown of Bartlett pears. *Jour. Agr. Research* 39:483-493.
- Investigations on the handling of Bartlett pears from Pacific Coast districts. *U. S. Dept. Agr. Tech. Bul.* 140. (With Calif. Agr. Exp. Sta.)
- Freezing and storing the Oriental persimmon. *Pacific Rural Press* 119:30.
- Chemical injury to watermelons in transit. *U. S. Dept. Agr. Circ.* 74.

CEREALS

- A cereal nursery seeder. *Jour. Amer. Soc. Agron.* 21:863-864.
- Effect of date of seeding on yield, lodging, maturity, and nitrogen content in cereal varietal experiments. *Jour. Amer. Soc. Agron.* 21:725-731.
- Bulked-population method of handling cereal hybrids. *Jour. Amer. Soc. Agron.* 21:718-724.
- Chromosome number and the mutation rate in *Avena* and *Triticum*. *Natl. Acad. Sci. Proc.* 15:876-881.
- Nuclear divisions in the pollen mother cells of *Triticum*, *Aegilops*, and *Secale* and their hybrids. *Jour. Agr. Research* 40:683-719.
- Flax cropping in mixture with wheat, oats, and barley. *U. S. Dept. Agr. Tech. Bul.* 133. (With Minn., N. Dak., Mont., S. Dak., Wis., and Ohio Agr. Exp. Stas.)
- Black stem rust of cereals has more than 60 physiologic forms. *U. S. Dept. Agr. Yearbook* (1929) 1930:137-140.

- The nematode disease of wheat and rye. *U. S. Dept. Agr. Farmers' Bul.* 1607.
- The cereal rusts and their control. *Sci. Agr.* 10:225-231.
- Scab of wheat and barley and its control. *U. S. Dept. Agr. Farmers' Bul.* 1599.
- The relation of cereal pests to changes in crop practices. *Sci. Agr.* 9:783-791.
- Hygroscopic moisture of flax seed and wheat and its relation to combine harvesting. *Jour. Amer. Soc. Agron.* 22:51-74.

BARLEY

- Earliness in F_1 barley hybrids. *Jour. Heredity* 20:557-560.
- Yields of barley in the United States and Canada 1922-1926. *U. S. Dept. Agr. Tech. Bul.* 96. (With Canada Exp. Farms.)
- The effect of a seed disinfectant on grain and straw yields and smut control in winter barley. *Jour. Amer. Soc. Agron.* 22:113-123.
- Should Nebraska grow more barley? *Nebr. State Bd. Agr. Ann. Rpt.* 1929:161-169.

CORN

- Correlation studies with inbred and cross-bred strains of maize. *Jour. Agr. Research* 39:677-721.
- Correlations between seed ear and kernel characters and yield of corn. *Jour. Amer. Soc. Agron.* 21:912-922. (With Kans. Agr. Exp. Sta.)
- Heritable characters of maize. XXXIV. Rootless. *Jour. Heredity* 21:78-80.
- The inheritance, interactions and linkage relations of genes causing yellow seedlings in maize. *Genetics* 15:253-282. (With Iowa Agr. Exp. Sta.)
- An inheritance study of the distribution of vitamin A in maize. II. Vitamin A content in relation to yellow endosperm. *Jour. Biol. Chem.* 86:161-165, 167-172. (With Purdue Univ. Agr. Exp. Sta.)
- The chemical composition of corn (*Zea mays*) seedlings. *Jour. Amer. Chem. Soc.* 51:2506-2522. (With Univ. Wis.)
- Determining the date of silking in experiments with corn. *Jour. Amer. Soc. Agron.* 22:280-283.
- The development of disease-resistant strains of corn. *Proc. Internatl. Cong. Plant Sci.* [4th], Ithaca, 1926, 1:155-159.
- Diseases of corn in Kansas. *Kans. State Bd. Agr. [Quart.] Rpt.* 28 (191):174-191.
- Effect of smut infection on the yield of selfed lines and F_1 crosses in maize. *Jour. Amer. Soc. Agron.* 21:1109-1112.
- False smut of maize, *Ustilagoidea*. *Phytopathology* 19:589-592.

FLAX (SEED)

- Dehiscence of the flax boll. *Jour. Amer. Soc. Agron.* 21:832-833.
- Place of flax in crop rotation system. *Dakota Farmer* 50:356.
- Flax facts. *Minn. Univ. Agr. Ext. Spec. Bul.* 128. (In cooperation.)
- Moisture content of flaxseed and its relation to harvesting, storage, and crushing. *Jour. Amer. Soc. Agron.* 21:818-831. (With Bur. Agr. Econ.)

OATS

- Registration of varieties and strains of oats. IV. *Jour. Amer. Soc. Agron.* 21:1175-1180.
- Unusual crossing in oats at Aberdeen, Idaho. *Jour. Amer. Soc. Agron.* 22:245-250.

- Oats in the North-Central States. U. S. Dept. Agr. Farmers' Bul. 1581.
 Oats in the western half of the United States. U. S. Dept. Agr. Farmers' Bul. 1611.
 Spring-sown red oats. U. S. Dept. Agr. Farmers' Bul. 1583.
 Oats of Fulghum variety win place in Southern States. U. S. Dept. Agr. Yearbook (1929) 1930: 398-400.
 Field studies on the rust resistance of oat varieties. U. S. Dept. Agr. Tech. Bul. 143.
 Oat varieties highly resistant to crown rust. (Note) Jour. Amer. Soc. Agron. 22: 573-574.
 The weedishness of wild oats. A reluctant and backbreaking study in adaptation. Jour. Heredity 20: 515-518.

RICE

- Distribution of anthocyan pigments in rice varieties. Jour. Amer. Soc. Agron. 21: 867-875. (With Calif. Agr. Exp. Sta.)
 Inheritance of anthocyan pigmentation in rice. Jour. Agr. Research 40: 1105-1128. (With Calif. Agr. Exp. Sta.)

SORGHUMS

- Spacing and date-of-seeding experiments with grain sorghums. U. S. Dept. Agr. Tech. Bul. 131.
 Chemical seed treatments for sorghum. Jour. Amer. Soc. Agron. 22: 472-475. (With Kans. Agr. Exp. Sta.)
 Bacterial streak disease of sorghums. Jour. Agr. Research 40: 963-976.
 Cultural characteristics of physiologic forms of *Sphacelotheca sorghi*. Phytopathology 20: 241-249.
 Methods of harvesting grain sorghums. U. S. Dept. Agr. Tech. Bul. 121. (With Bur. Agr. Econ., Bur. Pub. Roads, Kans. and Okla. Agr. Exp. Stas.)
 Tenuous kafir plants. Jour. Heredity 20: 565-566.

TEOSINTE

- Observations on tassels of teosinte malformed by *Sclerospora*. Jour. Agr. Research 39: 817-836.

WHEAT

- Registration of improved wheat varieties, IV. Jour. Amer. Soc. Agron. 21: 1172-1174. (With Kans. Agr. Col. and N. Dak. Agr. Exp. Sta.)
 The formative effect of day length on wheat seedlings. Jour. Md. Acad. Sci. 1: 115-126.
 Relation of leaf acidity to vigor in wheat grown at different temperatures. Jour. Agr. Research 39: 341-350.
 The water content of wheat leaves at flowering time. Plant Physiol. 4: 393-397.
 Varietal tests with wheat at the Sheridan field station. Wyo. Agr. Exp. Sta. Bul. 171. (In cooperation.)
 Varieties of hard red spring wheat. U. S. Dept. Agr. Farmers' Bul. 1621.
 Breeding hard red winter wheats for winter hardiness and high yield. U. S. Dept. Agr. Tech. Bul. 136.
 Varieties of hard red winter wheat. U. S. Dept. Agr. Farmers' Bul. 1585.
 The behavior of winter wheat in artificial environments. Science 71: 668-670.
 Breeding wheats resistant to bunt by the back-cross method. Jour. Amer. Soc. Agron. 22: 239-244.
 Factors which modify the resistance of wheat to bunt, *Tilletia tritici*. Calif. Agr. Exp. Sta. Hilgardia 4: 175-184. (In cooperation.)

- Inheritance of resistance to bunt, *Tilletia tritici*, in White Odessa wheat. Jour. Agr. Research 40: 353-359. (With Calif. Agr. Exp. Sta.)
 Inheritance of the second factor for resistance to bunt, *Tilletia tritici*, in Hussar wheat. Jour. Agr. Research 40: 225-232. (With Calif. Agr. Exp. Sta.)
 A mosaic of wheat transmissible to all cereal species in the tribe *Hordeae*. Jour. Agr. Research 40: 547-556. (With Wis. Agr. Exp. Sta.)
 Relation of stomatal behavior to stem-rust resistance in wheat. Jour. Agr. Research 39: 929-948. (With Minn. Agr. Exp. Sta.)
 The value of physiologic-form surveys in the study of the epidemiology of stem rust. Phytopathology 19: 951-959.
 Sulphur dusting for the prevention of stem rust of wheat. Phytopathology 19: 631-643.
 Wheat protected from black stem rust by dusting with sulphur. U. S. Dept. Agr. Yearbook (1929) 1930: 547-548.
 Effect of leaf rust (*Puccinia triticina* Eriks.) on yield of wheat. Jour. Agr. Research 40: 417-446. (With Purdue Univ. Agr. Exp. Sta.)
 Influence of varietal resistance, sap acidity, and certain environmental factors on the occurrence of loose smut in wheat. Jour. Agr. Research 39: 313-339.

FORAGE CROPS AND GRASSES

- Forage-crop seed imports vary much from year to year; sources world-wide. U. S. Dept. Agr. Yearbook (1929) 1930: 270-273.
 Seed production outlined. Summary aids growers of grasses and legumes. Oregon Farmer 49: 186.
 Increasing the protein content of pasture grasses by frequent light applications of nitrogen. Jour. Amer. Soc. Agron. 21: 845-853.
 Why our pastures deserve more consideration. East Texas 4 (4): 7, 46.
 Additional hosts of *Fusarium oxysporum* var. *medicaginis*. Jour. Agr. Research 39: 351-353. (With Kans. Agr. Exp. Sta.)

GRASSES

- How agricultural research can help the golfer. Bul. Green Sect. U. S. Golf Assoc. 10: 25-27.
 The grass trails of East Africa. Nat. Hist. 30: 48-59.
 Lawns in Florida. Fla. Agr. Exp. Sta. Bul. 209. (In cooperation.)
 Occurrence of the zonate-eyespot fungus *Helminthosporium giganteum* on some additional grasses. Jour. Agr. Research 39: 129-135.
 Leaf spot and foot rot of bluegrass. Bul. Green Sect. U. S. Golf Assoc. 9: 120-123.
 Leaf spot and root rot of Kentucky bluegrass, caused by *Helminthosporium vagans*. Jour. Agr. Research 40: 447-456.
 The production of Johnson grass for hay and pasturage. U. S. Dept. Agr. Farmers' Bul. 1597.
 Adulteration and misbranding of seed of reedtop, 1928. U. S. Dept. Agr. Serv. and Regulat. Announc., Bur. Plant Indus. (S. R. A.—B. P. I.) 15.
 Reed canary grass. U. S. Dept. Agr. Farmers' Bul. 1602.
 Isolation and purification of the alcohol-soluble protein (prolamin) occurring in English ryegrass (*Lolium perenne*). Jour. Agr. Research 40: 361-370.
 Timothy for hay seeded in wheat at different times and rates. Ohio Agr. Exp. Sta. Bimo. Bul. 139: 115-121. (In cooperation.)

Fertilizing timothy meadows with nitrate of soda. Ohio Agr. Exp. Sta. Bimo. Bul. 143: 44-49.
The relation of grasses to man. So. African Jour. Sci. 26: 133-138.

GREEN MANURE AND COVER CROPS

Green manuring and its application to agricultural practices. Jour. Amer. Soc. Agron. 21: 985-993.
Leguminous cover crops. Natl. Pecan Growers' Assoc. Proc. (1927/28) 27: 101-106.
Plantas tropicales para cultivos de cobertura y abonos verdes. Bol. Unión Panamericana. 64: 378-389, 535-553.

ALFALFA

Bacterial wilt of alfalfa. Jour. Amer. Soc. Agron. 22: 568-572.
Temperature and soil-moisture relations of *Fusarium oxysporum* var. *medicaginis*. Jour. Agr. Research 40: 97-103. (With Kans. Agr. Exp. Sta.)
Alfalfa root injuries resulting from freezing. Jour. Agr. Research 40: 121-143. (With Kans. Agr. Exp. Sta.)
Some factors involved in the winterkilling of alfalfa. Jour. Agr. Research 39: 263-283.

CLOVER (RED)

Red-clover problems turn on production of good domestic seed. U. S. Dept. Agr. Yearbook (1929) 1930: 449-452.
Influence of atmospheric and soil moisture upon seed setting in red clover. Jour. Agr. Research 39: 229-247. (With Ill. Agr. Exp. Sta.)

COWPEA

Mendelian factors in the cowpea (*Vigna species*). Mich. Acad. Sci. Arts and Letters, Papers 11: 240-283. (With Bur. Agr. Econ.)

SOYBEAN

Planting the soy bean green manure crop. Sugar Bul. 9(12): 4.
Soybean hay and seed production. U. S. Dept. Agr. Farmers' Bul. 1605.
Soybeans for feed and fertility. Assoc. South. Agr. Workers, Proc. 29: 71-74.
Soybean utilization. U. S. Dept. Agr. Farmers' Bul. 1617.
Soybean cheese. Science 70: 282-283.

SWEETCLOVER

Sweetclover growing by new methods is giving good results. U. S. Dept. Agr. Yearbook (1929) 1930: 501-503.

SEED TESTING

The application of statistical methods to seed testing. U. S. Dept. Agr. Circ. 79.
The botany of seed testing. Assoc. Off. Seed Anal. N. Amer. Proc. (1926/27) 19/20: 15-24.
Seed testing to show value for planting is increasingly necessary. U. S. Dept. Agr. Yearbook (1929) 1930: 472-476.
The vitality of buried seeds. Science 71: 561.

FIBER PLANTS

COTTON

Cotton of long staple could be produced in much greater quantity. U. S. Dept. Agr. Yearbook (1929) 1930: 202-207.

Cell-sap concentration and transpiration as related to age and development of cotton leaves. Jour. Agr. Research 40: 791-803.

Cotton breeding to-day works with main types known in remote past. U. S. Dept. Agr. Yearbook (1929) 1930: 182-190.
Hairy bolls and nectaries in a hybrid cotton. Jour. Heredity 20: 340-347.
Department develops new cotton of Egyptian type. U. S. Dept. Agr. Off. Rec. 9(21): 2.
"Maarad" cotton of Egypt same as Arizona Pima. U. S. Dept. Agr. Off. Rec. 9(18): 8.
The accuracy of cotton lint percentage figures. Jour. Amer. Soc. Agron. 22: 157-163. (With Tex. Agr. Exp. Sta.)
The occurrence of viable cotton root-rot sclerotia in nature. Science 70: 409-410.
Cotton root-rot investigations in Arizona. Jour. Agr. Research 39: 199-221.
Further studies of cotton root rot in Arizona, with a description of a sclerotium stage of the fungus. Jour. Agr. Research 39: 641-676.
Studies of cotton root rot at Greenville, Tex. U. S. Dept. Agr. Circ. 85.

HENEQUEN

A new variety of henequen without prickles. Jour. Wash Acad. Sci. 19: 415-416.

SUGAR PLANTS

SUGAR BEET

Studies on methods for control of pollination in sugar beets. Jour. Amer. Soc. Agron. 22: 1-9.
Selection characters as correlated with percentage of sucrose, weight, and sucrose content of sugar beets. Jour. Agr. Research 40: 523-546.
A study of the structure of sugar beets in relation to sugar content and type. Jour. Agr. Research 40: 867-915.
The seed production of sugar beets in relation to various temperature and moisture conditions of storing the roots. Facts About Sugar 25: 37-39, 48.
Attenuation of curly-top virus by resistant sugar beets which are symptomless carriers. Phytopathology 19: 975-977.
A new host of sugar beet curly top. Phytopathology 19: 1031-1035.
The sugar beet leaf-spot disease and its control by direct measures. U. S. Dept. Agr. Circ. 115.
A washing machine for root crops. Jour. Amer. Soc. Agron. 21: 860-863. (With Mich. State Col. Agr.)

SUGARCANE

The ditch bank method of planting sugar cane. Sugar Bul. 9(18): 4, 6.
The cane breeding station at Canal Point. Facts About Sugar 25 (17): 418-419.
A suggestion offering a means of improving quality of plant cane intended for milling purposes. Sugar Bul. 9(12): 11-12.
Development of flower and seed of some varieties of sugar cane. Jour. Agr. Research 39: 1-30.
Plot arrangement and some results of variety tests in Louisiana. Internatl. Soc. Sugar Cane Technol. 3d Cong., Soerabaia, 1929, Proc., p. 338-348.
Variety tests of sugarcane in Louisiana during the crop year 1927-28. U. S. Dept. Agr. Circ. 88.
Deterioration test of standing and wind-rowed plant cane of four leading varieties on Laurel Grove Plantation, Thibodaux, Louisiana. Sugar Bul. 9(13): 4-5. (With Bur. Chem. and Soils).

The effect of standing frozen cane on the stubble of the P. O. J. varieties grown in Louisiana. Sugar Bul. 8(9):5.
 Rate of deterioration of sugar content of some P. O. J. sugarcane varieties in Louisiana. U. S. Dept. Agr. Circ. 97.
 Plant quarantine practice in sugar cane migrations. Sugar 31: 343-344, 354.
 Sugar cane quarantine practice. Facts About Sugar 24: 953.
 Potash not a panacea * * * for mosaic disease of sugar cane. Facts About Sugar 25: 472.
 Fungi associated with root rots of sugar cane in the southern United States. Internatl. Soc. Sugar Cane Technol., 3d Cong., Soerabaia, 1929, Proc., p. 119-131.

SORGO

Varietal standardization of sorgo and the selection of seed. U. S. Dept. Agr. Circ. 52.
 Sorgo for sirup production, culture, harvesting, and handling. U. S. Dept. Agr. Farmers' Bul. 1619.

TOBACCO

A complete fertilizer for the tobacco crop. Amer. Fert. 72(6):36, 38, 48.
 Magnesium and calcium requirements of the tobacco crop. Jour. Agr. Research 40:145-168. (With N. C. Dept. Agr. Conn., Md., and N. C. Agr. Exp. Stas., Ga. State Col. Agr., and Ga. Coastal Plain Exp. Sta.)
 Rôle of chlorine in nutrition and growth of the tobacco plant and its effect on the quality of the cured leaf. Jour. Agr. Research 40:627-648. (With N. C. Dept. Agr., N. C., and Md. Agr. Exp. Stas.)
 Tobacco soil problems seriously affected by continuous crops. Tobacco 89(23):76-77.
 On the relation of potassium to iron in the combustion of cigar-leaf tobacco. Science 70:17-18. (With Penn. State Col.)
 Cigar-tobacco production in Pennsylvania. U. S. Dept. Agr. Farmers' Bul. 1580.
 Results of tobacco experiments in Pennsylvania, 1922 to 1927. Penn. Agr. Exp. Sta. Bul. 240. (In cooperation.)
 Field experiments on brown root rot. Conn. Agr. Exp. Sta. Bul. 311:247-255. (In cooperation.)
 Inactivation of the tobacco-mosaic virus by high pressures. Phytopathology 19:749-750. (With W. Va. Agr. Exp. Sta.)
 Breeding tobacco for resistance to Thielavia root rot. U. S. Dept. Agr. Tech. Bul. 175.
 Tobacco wild-fire. Wis. Dept. Agr. Bul. 98:117-119. (In cooperation.)
 Tobacco diseases are largely controllable by sanitary measures. U. S. Dept. Agr. Yearbook (1929) 1930:516-519.
 Steam sterilization of soil for tobacco and other crops. U. S. Dept. Agr. Farmers' Bul. 1629.

RUBBER

Madagascar expedition finds rubber plants possibly suited to U. S. U. S. Dept. Agr. Yearbook (1929) 1930:370-372.
 The anatomy of Euphorbia intisy. Jour. Agr. Research 40:615-625.
 Branching habits of the Hevea rubber tree. Science 71:386-387.

DRUG PLANTS

A botanical and chemical study of Bikukulla eximia, with a key to North American species of Bikukulla. Jour. Agr. Research 39:477-481.
 Toxicity of Bikukulla formosa (Western bleedingheart). Jour. Agr. Research 40:917-920.

Peppermint and spearmint as farm crops. Spec. Crops 28:173-176, 233-237, 268-270, 294-297, 327-330.

FOREIGN PLANT INTRODUCTION

Plant material introduced by the Office of Foreign Plant Introduction, Bureau of Plant Industry, January 1, 1927 to March 31, 1929 (Nos. 70868-80018). U. S. Dept. Agr. Inventory 90-98.
 Exploring for plants. 591 p., N. Y., Macmillan Co.
 Agricultural explorers ransack world for additions to American food crops. U. S. Daily 5 (78):4.
 Crop improvement by plant importation. Internatl. Crop Impr. Assoc. 11:10-11.
 Who's who with immigrant plants. Kans. Farmer 67 (44):7, 15.
 Hunting for plants in the Canary Islands. Natl. Geogr. Mag. 57:607-652.
 Exploring for plants in Ceylon with a weather eye toward the development of the American tropics. Asia 30:400-405, 451-454.
 Across Madagascar by boat, auto, railroad, and filanzana. Natl. Geogr. Mag. 56:179-212.
 Into primæval Papua by seaplane. Natl. Geogr. Mag. 56:253-332.
 The plant introduction garden at Chico. Calif. Dept. Agr. Mo. Bul. 19:47-50.
 The proposed national park in Southern Everglades of Florida. Fla. State Dept. Agr. Sup. Bul. n. s. no. 17.

ORNAMENTALS

Transplanting trees and shrubs. U. S. Dept. Agr. Farmers' Bul. 1591.
 Paper mulch use in ornamental plantings has proved effective. U. S. Dept. Agr. Yearbook (1929) 1930:403-406.
 Trailing arbutus. Wild Flower Preservation Soc. Inc., Circ. 19:1-3.
 Azaleas and rhododendrons from seed. U. S. Dept. Agr. Circ. 68.
 Bamboos valuable for ornamental use when properly situated. U. S. Dept. Agr. Yearbook (1929) 1930:124-125.
 Cacti. U. S. Dept. Agr. Circ. 66.
 Japanese spring in America. Asia 30:315-319, 378.
 Prunus yedoensis Mats. Yoshino. Natl. Hort. Mag. 9:46-48.
 Flowering dogwood. Wild Flower Preservation Soc. Inc., Circ. 18:1-3.
 Further notes on the treatment of peony root galls. Amer. Peony Soc. Bul. 24 (41):34-35.
 The bulb- or stem-nematode (Tylenchus dispaci Kühn) as a pest of phlox. N. Y. Bot. Gard. Jour. 30:177-184. (In cooperation.)
 A pink poinsettia chimera. Jour. Heredity 20:335-339.
 Bacterial blight of poppy caused by Bacterium papavericola, sp. nov. Jour. Agr. Research 40:1-23. (With Va. Truck Exp. Sta.)

BULBS

Americanizing Dutch bulbs. Amer. Florist 72 (5):9.
 A root rot of the white calla new to the United States. Florists' Exch. 73 (16):11, 13.
 Cape cowslip; a bulbous plant of great possibilities. Seed World 27 (4):19, 21.
 Accomplishments in daffodil culture. Seed World 27 (6):32-33.
 How should they be planted? * * * Recent daffodil history. Amer. Florist 72 (2188):8-9.
 Notes on daffodil storage tests in 1929. Florists' Exch. 73 (5):48, 52; (6):15.
 Additional notes on storage of daffodils in 1929. Florists' Exch. 73 (10):13, 55.

- Another possible method for saving our daffodils. *Florists' Exch.* 74 (9): 9.
 Daffodils in eastern North Carolina. N. C. Dept. Agr. Bul. [unnumbered]. (In cooperation.)
 Late news about narcissus basal rot control. *Florists' Exch.* 73 (4): 11.
 The use of fungicides in connection with the hot water treatment of narcissus bulbs. *Florists' Exch.* 72 (3): 13, 43.
 The production of hyacinth bulbs. U. S. Dept. Agr. Circ. 112.
 Further notes on iris behavior. *Amer. Iris Soc. Bul.* 35: 40-42.
 Some iris personalities. *Country Life* [Garden City, N. Y.] 58 (2): 35-39, 110.
 Handling bulbous iris in storage. Experiments in 1929 and conclusions drawn therefrom. *Florists' Exch.* 74 (1): 13.
 Notes on the propagation and culture of the most important commercial lilies. *Oreg. State. Hort. Soc. 42d Ann. Meeting, Ann. Rpt.* (1927) 19: 228-230.
 The production of lily bulbs. U. S. Dept. Agr. Circ. 102.
 Lily culture in the United States is making remarkable progress. *Seed World* 27 (11): 18-19.
 Easter lilies under glass. *Florists' Rev.* 65 (1671): 39.
 Lily diseases. *Oreg. State. Hort. Soc. 42d Ann. Meeting, Ann. Rpt.* (1927) 19: 217-220.
 Fighting the frost. *West. Florist* 13 (6): 3-4.

ROSE

- Roses for trellises and arbors are a result of hybridizing. U. S. Dept. Agr. Yearbook (1929) 1930: 465-467.
 Roses of everblooming habit available for most requirements. U. S. Dept. Agr. Yearbook (1929) 1930: 462-465.
 Two important rose varieties from bud-sports. *Amer. Rose. Soc., Amer. Rose Ann.* 1930: 200-202.
 Other gigantea hybrids. *Jour. Heredity* 20: 308.
 Diseases of rose caused by species of *Coniothyrium* in the United States. *Jour. Agr. Research* 40: 805-827. (With Brown Univ.)

BOTANY

- The relation of nomenclature to taxonomy. *Internatl. Cong. Plant Sci. Ithaca, 1926, Proc.* 2: 1434-1439.
 State and local floras. *Annotations by S. F. Blake. Wild Flower Preservation Soc. Bul.* 1.
 Effect of length of day on growth and development of plants. *Internatl. Cong. Plant Sci. Ithaca, 1926, Proc.* 2: 1050-1055.
 Vegetative propagation from the standpoint of plant anatomy. U. S. Dept. Agr. Tech. Bul. 151.
 Fifteen new species of grasses, six from Africa, nine from China. *Biol. Soc. Wash. Proc.* 43: 89-96.
 The grasses of Central America. *Contrib. U. S. Natl. Herbarium* 24: 570-762.
 Papuan grasses collected by L. J. Brass. *Linn. Soc. N. S. Wales Proc.* 54: 145-146.
 Three new grasses from French Sudan. *Jour. Wash. Acad. Sci.* 19: 303-304.
 New Asteraceae from the United States, Mexico and Honduras. *Jour. Wash. Acad. Sci.* 19: 268-281.
 Notes on certain type specimens of American Asteraceae in European herbaria. *Contrib. U. S. Nat. Herbarium* 26: 227-263.
 Two Cyperaceae new to the Boston district. *Rhodora* 31: 191-192.

- On the names of certain species of *Deguelia* (Derris). *Jour. Wash. Acad. Sci.* 19: 472-475.
 The giant cactus of Arizona. *Jour. Heredity* 20: 401-414.
 The *Opuntia basilaris* group. *Cactus and Succulent Soc. Amer. Jour.* 1: 245-246.
 The North American species of *Paspalum*. *Contrib. U. S. Natl. Herbarium* 28: 1-310.
 A new *Silene* from the Umpqua National Forest. *Biol. Soc. Wash. Proc.* 42: 207-208. (With Forest Serv.)
 Note on *Trisetum spicatum*. *Rhodora* 31: 255.
Wedelia comaxillaris Blake, sp. nov. *Jour. Bot.* 68: 48-49.
 The goatgrass situation in California. *Calif. Dept. Agr. Mo. Bul.* 19: 40-46. (With Forest Serv.)
 Wild garlic and its control. U. S. Dept. Agr. Leaflet 43.
 The municipal wild park; the National Arboretum. *Bul. Gard. Club Amer., ser.* 4, no. 7: 44-48.
 The National Arboretum. *Science* 71: 176-178.

MYCOLOGY

- Mycological nomenclature. *Internatl. Cong. Plant Sci. Ithaca, 1926, Proc.* 2: 1657-1660.
 Mycological nomenclature in relation to plant pathology. *Internatl. Cong. Plant Sci. Ithaca, 1926, Proc.* 2: 1225-1226.
 Certain early developmental phases common to many fungi. *Phytopathology* 19: 1117-1123.
 The production of normal sporophores in monosporous cultures of *Agaricus campestris*. *Mycologia* 21: 333-335.
 The problem of a natural classification of the Ascomycetes. *Internatl. Cong. Plant Sci., Ithaca, 1926, Proc.* 2: 1618-1626.
Botryosphaeria and *Physalospora* in the Hawaiian Islands. *Mycologia* 21: 313-320.
Coleodictyospora, a new genus of Dematiaceae. *Phytopathology* 19: 1051-1053.
 Polymorphism of *Leptosphaeria coniothyrium* (Fckl.) Sacc. *Phytopathology* 19: 879.
 Effects of ultra-violet radiation upon sporulation in *Macrosporium* and *Fusarium*. *Bot. Gaz.* 89: 113-136.
 The dehiscence of *Mycenastrum corium*. *Mycologia* 22: 103-105.
 Studies on the relation of temperature to the growth, parasitism, thermal death points, and control of *Mycogone perniciosa*. *Phytopathology* 20: 75-83.
 The taxonomy of *Peziza quernei*. *Mycologia* 21: 243-248.
 Repetitional diplanetism in the genus *Phytophthora*. *Jour. Agr. Research* 40: 557-573.
Pilacre faginea proves to be a heterothallic fungus. *Bul. Torrey Bot. Club* 56: 359-360.
 Concerning heterothallism in *Puccinia graminis*. *Science* 70: 308-309.
 A cytological study of heterothallism in *Puccinia graminis*. *Jour. Agr. Research* 40: 585-614. (With Calif. Agr. Exp. Sta.)
 Nuclear phenomena in *Puccinia triticina* physiologic form XI. *Internatl. Cong. Plant Sci. Ithaca, 1926, Proc.* 2: 1271-1278.
 The life history of *Sphaceloma ampelinum* de Bary. *Phytopathology* 19: 673-679.
Sphaceloma symphoricarpi. *Mycologia* 22: 106-110.
 Additional data on the distribution of two species of *Sphaceloma*. (Note) *Phytopathology* 20: 450.

Cytological evidence bearing on the sexuality and origin of life cycles in the Uredineae. Internatl. Cong. Plant Sci. Ithaca, 1926, Proc. 2: 1751-1766.
 Normal mushrooms from artificial manure. Science 70: 126-128.

PLANT DISEASES

Diseases of cereal and forage crops in the United States in 1928. Plant Disease Rptr. Sup. 71. [Mimeographed.]
 Diseases of fruit and nut crops in the United States in 1928. Plant Disease Rptr. Sup. 70. [Mimeographed.]
 Plant Diseases in Montana in 1928. Plant Disease Rptr. Sup. 69. [Mimeographed.]
 Plant diseases in West Virginia in 1928. Plant Disease Rptr. Sup. 72. [Mimeographed.]
 Disease in plants—a comparison with human disease. Ill. State Acad. Sci. Trans. (1927) 20: 328-341.
 Physiologic specialization in pathogenic fungi. Internatl. Cong. Plant Sci. Ithaca, 1926, Proc. 2: 1312-1330. (With Univ. Minn.)
 Some remarks on the physiological aspects of parasitism. Internatl. Cong. Plant Sci. Ithaca, 1926, Proc. 2: 1263-1270.
 The fungi of Iowa parasitic on plants. Iowa State Col. Jour. Sci. 3: 299-507. (In cooperation.)
 The relation of moisture to stomatal infection. Phytopathology 19: 751.
 Starchlike radiate crystals produced by *Bacterium marginatum* in starch media. Jour. Agr. Research 39: 495-501.
 Influence of bacteriophage on *Bacterium tumefaciens*, and some potential studies of filtrates. Jour. Agr. Research 39: 503-530.
 Mosaic diseases in the Canary Islands, West Africa, and Gibraltar. Jour. Agr. Research 39: 557-578.
 Nemas causing plant galls controlled best through crop rotation. U. S. Dept. Agr. Yearbook (1929) 1930: 391-394.
 Weather's influence on plant diseases important and frequently dominant. U. S. Dept. Agr. Yearbook (1929) 1930: 534-541.

FOREST-TREE DISEASES

Experience with case records. Natl. Shade Tree Conf. Pros. 1929: 22-25.
 Relation of pathology to forestry in the Northeast. Canad. Woodlands Rev. 1 (3): 7-8, 18.
 A simple tree injector. Phytopathology 20: 263-264.
 Some effects of the season of wounding on callous formation of tree wounds. Natl. Shade Tree Conf. Proc. 1929: 25.
 Quaking aspen. A study in applied forest pathology. U. S. Dept. Agr. Tech. Bul. 155.
 The large leaf spot of chestnut and oak associated with *Monochaetia desmezierii*. Mycologia 21: 324-325.
 Chestnut blight does not mean early end of tannin-extract industry. U. S. Dept. Agr. Yearbook (1929) 1930: 160-162.
 The tannin content of dead chestnut trees. Jour. Amer. Leather Chem. Assoc. 24: 479-499.
 The Dutch elm disease. Natl. Shade Tree Conf. Proc. 1929: 60-61.
 The history and distribution of *Phomopsis pseudotsugae* in Europe. Phytopathology 19: 970-992. (With Univ. Edinburgh.)
 The European larch canker. Natl. Shade Tree Conf. Proc. 1929: 58-59.

A physiological method of distinguishing *cronartium ribicola* and *C. occidentale* in the uredinial stages. Jour. Agr. Research 40: 105-120.
Dasyscypha fusco-sanguinea Rehm on western white pine, *Pinus monticola* Dougl. Phytopathology 19: 575-584.
Lentinus lepideus Fr.: A cause of heart rot of living pines. Phytopathology 19: 705-712.
Septoria acicola and the brown-spot disease of pine needles. Phytopathology 19: 993-999.
 Decay of slash of northern white pine in southern New England. U. S. Dept. Agr. Tech. Bul. 132.
 Experiments with bluestain fungi in southern pines. Phytopathology 19: 1101-1106. (With Bur. Ent.)
 Blue-staining fungi found in the United States. Phytopathology 19: 597-599.
 Some wood inhabiting fungi of Vermont. Joint Bul. Vt. Bot. and Bird Clubs 14: 28-50.
 New media for developing sporophores of wood-rot fungi. Mycologia 21: 197-203.
 Sap-stain and mold control at southern mills. South. Lumberman, 136 (1763): 60, 62.

WHITE-PINE BLISTER RUST CONTROL

The conduct of a forest investigation. N. Y. State Col. Forestry, Syracuse Univ., Empire Forester 16: 18-21.
 Blister-rust control makes progress in protecting white pine. U. S. Dept. Agr. Yearbook (1929) 1930: 140-141.
 Development of blister rust control in the Inland Empire. Northwest Sci. 4: 48-50.
 White-pine blister rust control in Connecticut. Conn. Agr. Exp. Sta. Bul. 314. (In cooperation.)

DRY-LAND AND IRRIGATION AGRICULTURE

Planting and care of shelter belts on the Northern Great Plains. U. S. Dept. Agr. Farmers' Bul. 1603.
 Work of the Huntley Field Station, Montana, in 1925 and 1926. U. S. Dept. Agr. Circ. 70.
 Work of the Newlands Field Station, Nevada, 1924-1927. U. S. Dept. Agr. Circ. 69.
 Irrigated crop rotations in southern Montana. U. S. Dept. Agr. Tech. Bul. 144.
 Result Newell lamb feeding experiments. Comparison of value of home grown feeds. Dakota Farmer 50: 478.
 Boron irrigation water may hurt citrus and walnut orchards. U. S. Dept. Agr. Yearbook (1929) 1930: 141-144.
 The boron content of oranges. Science 71: 542-543.

MISCELLANEOUS

Report of the Chief of the Bureau of Plant Industry (for the fiscal year ended June 30, 1929).
 Directory of field activities of the Bureau of Plant Industry. U. S. Dept. Agr. Misc. Pub. 64.
 Plant literature in world's current publications listed. U. S. Dept. Agr. Yearbook (1929) 1930: 410-412.
 A new vessel for the efficient aeration of bacterial cultures in liquid media. Jour. Bact. 19: 415-422.

- The nature and source of plant nitrogen. Jour. Franklin Inst. 208: 767-771.
- An automatic watering system with recorder for use in growing plants. Jour. Agr. Research 40: 233-241.
- Horticultural work of the United States Department of Agriculture. Gard. Chron. Amer. 33: 329.
- Speaking of trees. Natl. Hort. Mag. 8: 115-116.
- Palestine rubs its eyes. Ancient land of Bible adopting methods responsible for California's horticultural advance. Los Angeles Sunday Times, Farm and Gard. Mag. Dec. 22, 1929, p. 3, 8-9.
- Biological control of the prickly pear in Madagascar. Science 70: 37.
- The influence of the combine on agronomic practices and research. Jour. Amer. Soc. Agron. 21: 766-773.
- Plot arrangement to distribute neighbor influence in field trials. Phytopathology 19: 565-574.
- A useful holder for plat stake labels. Jour. Amer. Soc. Agron. 22: 188-189.
- St. Luther. A Burbank cult, with an account of his wonder-working methods of plant breeding. Jour. Heredity 20: 309-318.
- Tōji Nishida 1874-1927. Phytopathology 19: 881-883.
- William A. Orton. Science 71: 89-91.

REPORT OF THE CHIEF OF THE PLANT QUARANTINE AND CONTROL ADMINISTRATION

UNITED STATES DEPARTMENT OF AGRICULTURE,
PLANT QUARANTINE AND CONTROL ADMINISTRATION,
Washington, D. C., August 15, 1930.

SIR: I submit herewith a report of the work of the Plant Quarantine and Control Administration for the fiscal year ended June 30, 1930.

Respectfully,

LEE A. STRONG, *Chief.*

Hon. ARTHUR M. HYDE,
Secretary of Agriculture.

INTRODUCTION

Some two years ago C. L. Marlatt, who was chairman of the Federal Horticultural Board from its creation, and who became Chief of the Plant Quarantine and Control Administration upon the reorganization of the department's plant-regulatory work in 1928, asked to be relieved of the duties of chief of this administration in order that he might devote his entire time to the position of Chief of the Bureau of Entomology, he having been chief of the two organizations for some time. Circumstances which could not be controlled prevented the request being granted at the time made, and it was not until December 1, 1929, that Doctor Marlatt was given relief from the burden of responsibility for both organizations and enabled to devote his full time to the direction of the Bureau of Entomology. This report, therefore, covers the work done under the direction of Doctor Marlatt during the first five months of the fiscal year, as well as that of the remaining seven months of the year.

The second year of the Plant Quarantine and Control Administration serves further to demonstrate the wisdom of the reorganization of the plant-quarantine work which became effective July 1, 1928. The facility with which men and equipment may be transferred and utilized and the centralization of control of finances and direction of activities make for constantly increasing efficiency and simplification of operation.

While the normal and inevitable extensions of quarantines have been necessary during the year under discussion, there has been no new quarantine placed, and one quarantine has been removed. On February 20, 1930, the Secretary of Agriculture, upon the recommendation of this administration, announced the revocation of the quarantine adopted the previous year to prevent the spread of the Asiatic beetle and the Asiatic garden beetle. It was stated that

the habits and economic status of these insects did not appear to warrant the maintenance of a Federal quarantine.

As pointed out in previous reports, the quarterly Service and Regulatory Announcements published by the administration constitute a permanent record of new quarantines and of revisions and modifications of those already in force. In bringing down to date in readily accessible form the latest quarantine regulations, the announcements are of especial interest and assistance to State inspection officials of the various States acting in the capacity of State officials and also as collaborators or agents of the Plant Quarantine and Control Administration. These announcements also contain material which is not published elsewhere and which constitutes a valuable history of the quarantine work in the United States, including, among other features, opinions as to legality of and necessity for certain quarantine regulations written by competent legal and other authorities.

For effective and economical operation the work of the administration is divided into nine units. Two of these units have headquarters in Washington. The other seven, dealing with control and eradication projects, have headquarters in the field.

One of the units with headquarters in Washington deals with the enforcement of quarantines governing the entry of plants and plant products into the United States from foreign countries and is under the general direction of E. R. Sasscer.

The other division in Washington has to deal with domestic quarantines for which no definite field unit is established and is under the direction of S. B. Fracker.

The field units are as follows:

Work dealing with the control and prevention of spread of the corn borer is under the general direction of L. H. Worthley, with headquarters at Boston, Mass. For effective operation this area is divided into three districts—i. e., eastern area, with headquarters at Boston, Mass.; central area, with headquarters at South Norwalk, Conn.; and western area, with headquarters at Toledo, Ohio.

The work on the gipsy moth is under the field direction of A. F. Burgess, with headquarters at Melrose Highlands, Mass.

The work on the Japanese beetle is under the field direction of C. H. Hadley, with headquarters at Camden, N. J.

The work on the pink bollworm and *Thurberia* weevil is under the field direction of R. E. McDonald, with headquarters at San Antonio, Tex.

The work dealing with the eradication of *Parlatoria* date scale is under the field direction of B. L. Boyden, with headquarters at Indio, Calif.

The work dealing with the Mexican fruit worm, with headquarters at Harlingen, Tex., is under the field direction of P. A. Hoidale. M. H. Ford has been acting in charge, while Mr. Hoidale was assigned to certain phases of the work in connection with the eradication of the Mediterranean fruit fly.

Because of the emergent situation the field headquarters for work on the Mediterranean fruit fly have been maintained at Orlando, Fla. The field direction of this work is discussed elsewhere in this report.

The tables included in this report are a continuation of those published each year since the creation of the Federal Horticultural Board

and constitute a record of imports of plant products, conditions of infestation of crops, orchards, and forests in this country, and of the enforcement of important plant-pest quarantines, this information not being available elsewhere in this particular form.

Probably the outstanding development in insect infestation as affecting American agriculture was the finding of an exceedingly heavy infestation of pink bollworm in a large area in the Salt River Valley of Arizona, where the growing of Pima or long-staple cotton is a specialty. The department, with the cooperation of the State Commission of Agriculture and Horticulture and the citizens of Arizona, undertook eradication measures. This undertaking is discussed at greater length later on in this report. The principal measures consisted of the establishment of a noncotton zone by the State authorities involving some 47,150 acres, 36,124 acres being in the noncotton zone proper and 11,026 acres in a restricted zone surrounding the noncotton zone, and the clean-up of the fields by this administration. An appropriation of \$587,500 for the clean-up was promptly granted by Congress in the emergency. The outlook is very encouraging for eradication of the pest in this area unless unforeseen difficulties arise.

As an aid to eradication and in consonance with a policy previously followed by Congress in pink-bollworm eradication campaigns in Texas and Louisiana, Congress has authorized an appropriation of \$2,500,000, from which amount the Federal Government will compensate the cotton growers for one-half of the actual and necessary losses sustained by reason of the nonproduction of cotton, conditioned on the State concerned compensating for the other half of the actual and necessary losses.

DOMESTIC PLANT QUARANTINES

MEDITERRANEAN FRUIT FLY

The Mediterranean fruit fly has continued to occupy the attention of the Plant Quarantine and Control Administration and of Congress; and while it is too early to draw conclusions as to the ultimate outcome, present indications point most forcibly to a remarkable accomplishment in the way of reduction of population of the fly in Florida in the first season of eradication effort. Under the police power of the State and with the active cooperation of the responsible citizens of Florida, the results were accomplished largely through the application of poison bait and through the enforcement of clean culture methods.

At the end of the period covered by this report, no fruit fly had been found in Florida since March 4, 1930, at which time 10 larvæ were found in two sour oranges in a grove in the city of Orlando. Prior to that time but one infestation had been found since August 27, 1929, namely, one orange containing four larvæ found in a grove 10 miles west of Orlando on November 16, 1929.

On account of scarcity of funds, no field inspection was possible during the period between March 27 and June 13, so that more than two months of valuable inspection were completely lost.

As before stated, it is too early to draw definite conclusions. The unavoidable suspension of activities by the department may ultimately be responsible for the permanent establishment of the fly by preventing the conduct of eradication measures at a time when the

program was in an especially favorable position. If the fly has been eradicated, this has been accomplished with much less loss of property than was anticipated at the beginning of the campaign. As compared with the citrus-canker eradication campaign conducted in Florida by the State Plant Board from 1914 over a period of several years, the destruction of property was much less. Despite charges of wholesale destruction, the fact remains that the plant commissioner of Florida reports that there were destroyed by official forces in Florida in the fruit-fly eradication campaign some 608,000 boxes of citrus fruits, much of which would probably not have been marketed in any event; approximately 50,000 bushels of host vegetables; and less than 28,000 bushels of minor and noncitrus fruits.

In the citrus-canker eradication campaign there were destroyed between May, 1914, and November 30, 1916, 105,714 orchard citrus trees and 2,888,832 nursery citrus trees; this destruction took place without compensation to the growers.

APPROPRIATIONS

Naturally, in dealing with an imported pest never before present in the United States, and with a history indicating beyond doubt that it would be especially serious to the fruit cultures of this country, it was imperative that the department request appropriations adequately to take care of any contingency which might arise in the eradication campaign. In this connection good judgment dictated the request of appropriations of sufficient size to guarantee that money and facilities would be available successfully to conclude the campaign if possible. Therefore, an estimate of \$15,381,000 was submitted to the Bureau of the Budget and forwarded to Congress by the President. A large part of this money was regarded as a form of insurance to take care of any unforeseen conditions that might arise; and for use, if necessary, in the destruction of many hundred thousand acres of wild host plants should the fly show a tendency to spread from the cultivated fruits to these wild fruits in uncultivated lands.

The appropriation met with resistance in Congress; although the estimate was submitted by the President to Congress on December 8, 1929, final action was not taken until the regular appropriation bill was passed by both Houses on May 20, 1930, and signed by the President May 27. In the interim, however, an emergency appropriation of \$1,290,000 was made by Congress and approved by the President on December 21, 1929. On March 20, 1930, on account of conditions found by inspection to exist in Florida at that time, the President recommended to Congress that instead of the \$15,381,000 requested for the period December 15, 1929, to July 1, 1930, there be appropriated \$6,902,404 to carry on the work from that time until November 30, 1930. Of this amount, \$1,500,000 was to be set up as an emergency reserve to be used only in case an unforeseen exigency should arise. With the passage of the regular appropriation bill for the fiscal year 1931, there was made available for the Mediterranean fruit-fly work in Florida, \$1,740,000, and in addition there was appropriated an emergency fund of \$1,500,000 to be used when the President of the United States decided that infestations of sufficient number and intensity were found in Florida to justify its expenditure.

ADVISORY COMMITTEES

From the inception of the fruit-fly work immediately after the discovery of the pest in April, 1929, until March 29, 1930, the eradication measures were directed by Wilmon Newell, Gainesville, Fla. In addition, the department during the summer and fall was advised on general policies by two committees of well-known specialists, who, at the Secretary's request, studied the situation in Florida. The personnel and report of the first of these committees were presented in the last annual report of the administration.

In the fall of 1929 a second special committee was appointed to review the situation as it was at that time. The personnel of this committee was as follows: W. O. Thompson, president emeritus of Ohio State University; W. C. Reed, commercial fruit grower of Vincennes, Ind.; W. P. Flint, chief entomologist of the Illinois Natural History Survey; W. H. Alderman, head of the department of horticulture, University of Minnesota; and J. J. Davis, head of the department of entomology, Purdue University. The report of this group has been published in full in the Service and Regulatory Announcements of the administration. It stated that "the appropriations already made for the eradication program have been so effectively used that infestation is not now apparent. The failure to continue the program of eradication as a measure of precaution might threaten the efficiency of the work already accomplished. In addition an emergency fund as a reserve might well be provided and made available only in case of new outbreaks in outside areas which would constitute emergencies."

FEDERAL FRUIT FLY BOARD

In order to have the best available advice continuously on the fruit-fly eradication work in Florida the Secretary of Agriculture, on January 9, 1930, announced the appointment of a Federal fruit-fly board composed of five of the outstanding entomologists of the United States. These men were W. C. O'Kane, State entomologist of New Hampshire, chairman of board; George A. Dean, professor of entomology, Kansas State Agricultural College; W. P. Flint, State entomologist of Illinois; P. J. Parrott, entomologist of the New York Experiment Station; and J. J. Davis, professor of entomology at Purdue University. These men, at considerable personal sacrifice, accepted the appointment and went to Orlando, Fla., to sit as a board to study the entire fruit-fly question, to determine and put into effect eradication policies, and to supervise the expenditure of Federal funds.

Wilmon Newell, who had been the executive officer in charge of eradication from the beginning of Federal participation in the fruit-fly work, was given his choice of remaining executive officer or of taking a place on the Federal fruit-fly board. He chose to remain executive officer. Doctor Newell continued in this position until Federal activities were suspended by reason of lack of funds, when he resigned to devote his entire time to State activities. W. C. O'Kane, chairman of the Federal fruit-fly board, was then placed in charge of the Federal quarantine activities in Florida and has since continued to act in that capacity.

The Federal fruit-fly board has been responsible for many substantial modifications of the quarantine, which modifications were based on their study of the numerous questions involved.

NO INFESTATION FOUND OUTSIDE FLORIDA

Extensive surveys for the purpose of determining whether the fruit fly had spread to other Southern States were carried on throughout the summer and fall in cooperation with the agricultural departments of the States concerned. General headquarters were maintained at Atlanta, Ga., for this purpose, and inspectors from that office were assigned to scout all parts of the South. Fruit was examined as it matured in the commercial fruit-growing sections of that region, and also as much attention as possible was given to areas where horticulture was of less commercial importance.

This work reached its maximum in July, 1929, when fruit-fly inspections were made on 30,737 different premises in the States of Alabama, Arkansas, Georgia, Louisiana, Mississippi, New Mexico, North Carolina, South Carolina, Tennessee, and Texas. It was continued in six of these States through September, and in Alabama, Georgia, and Mississippi in October. From the end of October until such scouting was discontinued entirely in February, the work was confined largely to Alabama and Mississippi, all expenses in the latter State being defrayed by the Mississippi State Plant Board. A special survey of the citrus area of Louisiana was made in December, when the fruit on 90 premises was examined.

So far as the department can determine, the Mediterranean fruit fly has not succeeded in establishing itself at any point in the United States outside the State of Florida.

ERADICATION MEASURES

The methods used to exterminate the fruit fly were described in some detail in the last annual report and in the Service and Regulatory Announcements of the administration. They included essentially (1) the clean-up of infested properties as rapidly as found, and the removal of such host fruits and vegetables as appeared necessary to eliminate infestation on the infested properties; (2) the application to trees in infested localities of sweetened poison bait to destroy the adult flies; and (3) the destruction of all summer-ripening fruits and vegetables in the infested zones and, to some extent, in the surrounding protective zones.

As a basis for carrying out these measures, the Federal quarantine as revised on August 20, 1929, classified the various parts of Florida as follows: Those properties lying within one mile of points at which the Mediterranean fruit fly had been discovered were designated as "infested areas" and specially stringent requirements were enforced as to such locations. These areas were all within a group of twenty counties in the central part of the State. This large district, which included all points reached by the fly and at least ten miles beyond the outermost points of infestation, was designated as the "eradication area" and its boundaries were specified in detail in the Federal quarantine regulations. The eradication program was undertaken throughout that area. Restrictions on counties lying outside it were confined primarily to such safeguards as were necessary to avoid danger of the fly spreading to outside States from such outlying infestations as might remain undiscovered.

The eradication work was carried out in cooperation with and enforced under the authority of the State Plant Board of Florida. It was pressed vigorously until January 11, when it was found that the

rapid depletion of funds made it necessary to concentrate on quarantine enforcement, field-survey activities, and certification of products for movement out of Florida. Consequently the clean-up section of the organization was disbanded on that date, and the only work of this kind thereafter was that which was voluntarily carried on by the growers themselves, except in the case of the March 4 infestation. At this time such clean-up and spray work as was necessary to destroy the infestation was conducted.

From April 6, 1929, to January 11, 1930, inclusive, Federal and State clean-up activities had covered 120,157 acres of citrus groves in the infested zones an average of approximately four times, and had involved the destruction of the equivalent of approximately 608,940 boxes of citrus fruit. This work was confined to the infested areas until early in October, when it was extended to those parts of the eradication area outside. By the time the work had been discontinued, approximately 61,847 acres outside the infested areas had been covered an average of between two and three times, and some nine times. The amount of citrus fruit destroyed in these outside areas totaled the equivalent of 24,982 boxes. Similar clean-up activities were extended to the cultivated noncitrus areas and the uncultivated lands in the infested areas, and to a very limited extent to such lands outside such infested zones. These activities involved the employment of from 2,000 to 3,200 laborers until the 1st of October, when the crews were reduced to from 150 to 450 men.

In the meantime, a poison-bait spray was being used throughout the infested zones and to some extent was applied also in other parts of the eradication area. Most of this area was sprayed repeatedly, the general policy being to respray it each week. The maximum number of sprayings on any group of properties totaled 19 on an area of 596 acres. Almost 300,000 pounds of lead arsenate were used in the spraying operations.

FRUIT STERILIZATION BY HEAT OR COLD

By early in July, 1929, department investigators had worked out methods which showed that fruit sterilization might be used to destroy any stage of the fruit fly present in fruit but which was not discovered in field inspection. These experiments continued to prove successful and by September 20 had reached such a stage that the department was able to authorize the interstate movement of fruit so sterilized to hitherto closed markets. The method authorized on that date was to hold the fruit at a temperature of 28° F. for five hours, followed by holding at 30° for a period of five days from the time the fruit reached 28°. Later, on October 23, a second method was authorized, involving heating the fruit to a temperature of 110° at the approximate center of the fruit and holding at that temperature for a period of eight hours. These two treatments had both been found fatal to the eggs and larvæ of the Mediterranean fruit fly. Either the maximum or minimum temperatures required for sterilization could be obtained by modification of existing practices in the handling of citrus fruits.

These methods were not used as a means of authorizing the movement of infested fruit, as all such fruit was promptly destroyed upon discovery. The requirement of sterilization was applied to fruit

believed to be entirely free from the pest and was employed with the object of eliminating any possible residual risk.

Continued investigations showed that a more desirable and equally efficient method of cold sterilization was to lengthen the time of exposure to 15 days and to hold the fruit at a temperature between 30° and 31° F. This plan was authorized on March 4, 1930, and thereafter was used by the cold storages in place of the lower temperature previously employed.

All host fruits moving from any part of the State of Florida to the Southern and Western States (except limes from certain areas), and all fruit shipments moving from the eradication area to Virginia, West Virginia, and the Middle Western States were required to be sterilized, either in Florida or at an approved northern cold-storage plant. Such sterilization was not used with noncitrus fruits or with vegetables.

Under the regulations, all host fruit produced in infested areas—that is, within 1 mile of infested properties—was also required to be sterilized as a condition of interstate movement. As all such infested zones were released by the State plant board, with the approval of the Federal department, comparatively early in the shipping season (October 12 and November 30), this requirement materially affected only two areas of 3 square miles each, both in Orange County, one surrounding the infestation of November 16, 1929, and the other around the infestation of March 4, 1930.

DISTRIBUTION OF FLORIDA FRUIT TO SOUTHERN STATES RESTRICTED

In recognition of the fact that the Mediterranean fruit fly primarily is a pest of countries of a subtropical climate, the department, from shortly after the original discovery of the pest, has placed more stringent restrictions on the distribution of Florida host fruits and vegetables to the Southern States than those applying to such movement to the North. From May 16 to November 20, 1929, inclusive, such fruits and vegetables, except limes from certain areas, were not allowed to be shipped from the infested State into the States bordering the Gulf of Mexico, the Mexican border, and the Pacific coast, or into most of the States which are immediately north of those named.

In view of the efficiency of sterilization, however, and of the improved general status of the fruit-fly infestation, an order was issued on November 18, 1929, authorizing the movement of sterilized host fruits into the Southern and Western States for the period of November 21, 1929, to January 31, 1930. The final date was later extended to February 28. At the same time, the movement of green tomatoes produced outside the eradication areas was authorized throughout the continental United States. This same authorization was extended on April 9 to cover eggplants. Sour limes, being highly resistant to infestation, have also been permitted to move into the Southern and Western States from certain sections of Florida throughout the year.

When the method of insuring freedom from infestation by means of sterilization was devised, it was anticipated that such sterilization would be required for all Florida fruit, at least for that produced within the eradication area. The limited time between demonstrations of the efficiency and practicability of these methods, and the beginning of the shipping season, however, made it impossible for sufficient equipment to be installed in the packing houses of Florida

in time to sterilize the entire crop even of the eradication area. It was clear to the department that if any infested fruit should escape the inspection system employed within that area and reach interstate distribution, it was least likely to result in the establishment of infestation if shipped to the extreme northeastern sections of the United States. This was true both because of the climatic conditions of the Northeastern States and the fact that the large consuming population of that region rapidly disposed of the fruit; there was also comparatively small demand for redistributing the fruit to the South and West. Therefore the sterilization of host fruits and vegetables moving from Florida into the area northeast of the Potomac River and the western boundary of Pennsylvania was not required, and the reshipment of such products from that area to the South and West was prohibited. Throughout the entire shipping season, however, the sterilization of fruit shipped from the eradication area to the Middle Western States was required.

HIGHWAY MOVEMENT CONTROLLED

The interstate movement of host fruits and vegetables from Florida by means of road vehicles has been prohibited from the beginning of the campaign, and the State of Florida has placed similar restrictions on intrastate movement from the eradication area to outside points.

Since the eradication area was first defined on August 20, 1929, this work has involved the maintenance of three separate border-patrol organizations. The first of these has been maintained by the United States Department of Agriculture on the north boundary of the State of Florida to prevent any interstate movement of host fruits and vegetables from Florida by road vehicles. This work was carried out on 19 highways on the Georgia-Florida border and 9 highways on the Alabama-Florida border, and in addition 7 movable patrols were used to make interceptions on roads of lesser importance. The border patrol on the Alabama line was discontinued at the end of February, following a release of west Florida from the Mediterranean fruit-fly quarantine restrictions, and thereafter the men who had been operating them were transferred to the highways crossing the Ocklockonee River in western Florida. While the border patrol was being maintained throughout the entire length of the north boundary of Florida, from 100,000 to 135,000 automobiles per month were stopped, of which from 2,000 to 3,000 per month were found to be carrying fruits, vegetables, or other restricted articles. After the line had been shortened by the transfer of the Alabama section to the Ocklockonee River, from 70,000 to 90,000 vehicles per month were inspected, of which from 2,400 to 4,100 per month were found to be carrying fruits and vegetables.

The other two border-patrol organizations have been maintained under the authority of the State Plant Board of Florida to control intrastate movement (1) from the eradication area to the southern uninfested counties of the State, and (2) from the eradication area to the northern and western parts of the State. At these road stations, from 240,000 to 460,000 vehicles per month have been inspected, of which from 2,500 to almost 6,000 per month have been found to be carrying contraband articles.

To prevent the unauthorized movement of restricted articles in personal baggage by trains, passengers were not allowed to carry

such baggage on the trains until after the parcels had been inspected to ascertain that they were free from fruits and vegetables. From 40 to 50 stations were maintained for this purpose, manned by some 200 inspectors. In this work, from 100,000 to 250,000 pieces of baggage per month were inspected, of which from 200 to 1,000 were found each month to contain contraband articles.

The reshipment restrictions prohibiting the transportation of Florida fruits and vegetables which had been shipped to the mid-western or to the northeastern parts of the United States, respectively, were enforced in a somewhat similar manner but without the maintenance of permanently established stations. From 2 to 10 men were employed at different times of the year on this work, watching the highways along the border between these areas and visiting grocery stores south and west of the border to determine the source of their supplies.

One hundred and fifty-two violations of the regulation which prohibited the reshipment of Florida host fruits and vegetables from Maryland, Pennsylvania, and the District of Columbia, and points northeast thereof, to points to the south and west, were intercepted and the material involved was either confiscated or required to be returned to the point at which it was purchased. Similarly 237 violations of the regulations restricting the movement of such Florida products from Virginia, Kentucky, Missouri, and other Northern States to the Southern States were detected, and in many of the latter class of cases prosecutions were instituted.

CAR-CLEANING REQUIREMENTS

The cleaning of railway cars which had been used in the transportation of such restricted articles from Florida was required, in order to prevent those which had been loaded with Florida fruits and vegetables from carrying infestation to other horticultural areas of the United States after the Florida lading had been removed. This restriction was enforced by placing inspectors at such important railroad-distribution points as Potomac Yards, Cincinnati, Louisville, St. Louis, Chicago, Detroit, Savannah, Waycross, and certain other points, to examine all empty refrigerator cars moving through those terminals. As a result of such inspections, 14 cars were intercepted dirty in October; 61 in November; 340 in December; 84 in January; 212 in February; 132 in March; 131 in April; 68 in May; and 74 in June, a total of 1,116. Such intercepted cars were cleaned at the point of interception under orders by the department, and the railroad which should have cleaned them at the previous unloading point was notified. The number of such interceptions amounted to less than 3 per cent of the total crop movement, indicating a very high degree of compliance with these requirements on the part of the railroads concerned. In about half the interceptions investigated it was found that the railroad employees had partially cleaned the cars but had not used sufficient care.

In addition to the figures given above for interstate movement, 395 dirty cars, many of which had been employed in the intrastate transportation of restricted articles, were found in the Jacksonville area in Florida between January 1 and June 30, and ordered cleaned there.

BOAT MOVEMENT

Shipments by boat proved more difficult to control than those by rail. No clearance is required in harbors of the United States for coastwise vessels. Port inspectors of the administration were able, however, to a large extent, to check on quarantine compliance at many ports, both in Florida and elsewhere. Ships' stores were also examined as opportunity offered. It was found, for example, that of 356 vessels visiting Charleston, S. C., between September 8, 1929, and June 30, 1930, 24 had Florida fruits or vegetables on board for the passengers and crew. These supplies were in all cases safeguarded while in port and were not allowed to be taken ashore. At the request of the department orders were issued to commanders of vessels of the Navy, Army, and Coast Guard that Florida host fruits and vegetables were not to be stocked on boats likely to stop at southern ports of the United States.

GIPSY MOTH AND BROWN-TAIL MOTH

CONDITION OF GIPSY-MOTH INFESTATION IN NEW ENGLAND

As predicted in the last annual report, the acreage defoliated by the gipsy moth increased sharply during the summer of 1929, over 550,000 acres being involved. This was more than double the acreage of the previous year. Heavy increases were recorded in Maine and New Hampshire, the acreage being the greatest of any year since these States became infested. In Massachusetts the acreage decreased about one-third, based on the figures of the previous year, while in the other States a greater decrease was noted. The acreage that will be defoliated during the summer of 1930 will show a substantial reduction from the high figures recorded for the previous year. This is particularly true in towns where enormous forest areas were completely defoliated in 1929. Depletion of foliage usually results in a scarcity of the insect during the following year or until sufficient time has elapsed to allow the pest to increase.

On account of the abundance of the insect more intensive clean-up and control work has been done by the State and town authorities and by owners of trees for the protection of their own property. The greater part of these expenditures, however, has been made in the cities and towns or on trees growing along the highways.

In the barrier-zone area in the western part of New England and eastern New York, an increasing number of infestations was found during the summer and fall of 1929. The danger of this situation was that most of these infestations were found in dense woodland areas and the expense of scouting such territory was very heavy. In March, 1930, a deficiency item of \$100,000 was appropriated by Congress to make possible the examination of large areas of woodland in the barrier zone that could not otherwise have been scouted during the year, and thoroughly to clean-up and spray the infested areas that were discovered.

EXTERMINATION WORK IN NEW JERSEY

Prior to the close of the last fiscal year a single gipsy-moth infestation was found in the township of Piscataway, near the North Plainfield and Hillsboro town lines. This was the only infestation found

in New Jersey during that year. The area was thoroughly treated and sprayed, and since that time careful scouting work has been done not only in the area where the insect was found but in a territory surrounding it within a radius of about 2 miles. No further infestation has been found as a result of this work. It appears, therefore, that the 10-year effort to eradicate the pest from New Jersey has been almost accomplished.

In July, 1929, as a further check on the scouting work that had been carried on during the previous winter, assembling cages which are used to attract male moths, were placed in every locality where there was a suspicion that the insect might possibly exist. Although 1,241 such cages were used, no moths were caught at any of them.

The area where intensive work was required was reduced to approximately 137 square miles.

During the winter of 1929-30, careful inspection work was carried on in 11 towns where infestations were found and cleaned up several years ago, in order to determine whether the insect had escaped detection in any of these places, but no infestation was found. Intensive scouting was carried on throughout the entire townships of North Plainfield and Warren, the southern portion of Bernard and Hillsboro, and a section in the northern part of Bridgewater. This work was very intensively done, all tree growth being examined throughout these areas. No gipsy moths were found as a result of this work.

During the fiscal year 1930, 1,664 shipments of nursery stock and forest products were inspected and certified before they were shipped from the area under State quarantine. No gipsy moths in any stage were found on any material offered for shipment.

In the spring of 1930, a small spruce tree was found at Interlaken, N. J., that had been shipped in from Long Island the previous fall. A gipsy-moth egg cluster was found on this tree. It was treated and later in the season the tree and surrounding area were thoroughly sprayed, and there is no doubt that the insect has been exterminated at this point.

The results during the past year have been very encouraging, and it will be possible during the coming fiscal year further to reduce the area where intensive work will be required, which marks another step in the extermination of the insect in New Jersey.

THE GIPSY MOTH ON LONG ISLAND

In December, 1929, the gipsy moth was reported on trees growing in nursery grounds at North Roslyn, Long Island. At various times during the last 10 years small infestations of this insect had been found in different towns on Long Island and cleaned up by the State of New York, in many cases with the cooperation of the Federal force. An investigation showed that the infestation at North Roslyn was serious and covered quite an extensive area. Scouting and clean-up work were carried on during the months of January and February, 1930, by the Federal force in an area somewhat less than 3 miles in radius surrounding the point where the pest was first found. Out of a total of 4,416 egg clusters located and treated before the 1st of March, 1930, 3,619 were located in the village of North Roslyn which proved to be the center of infestation. The other egg clusters, with the exception of a single case found within 3 miles of North

Roslyn, were all located within an area of less than 2 miles from the center of infestation.

While this work was going on the conservation department of the State of New York furnished a number of crews of men who carried on scouting work in the territory beyond the area that was being scouted by the Federal force. As a result of this work a single small infestation was found near Syosset.

It was evident at the outset that the entire territory in Nassau County, comprising the townships of North Hempstead, Hempstead, and Oyster Bay, should be examined because many shipments of nursery stock had been removed and planted in this county which were grown by establishments located near North Roslyn.

Beginning March 1, the scouting work and the spraying of infested areas was supervised and managed by the conservation department of the State of New York. On account of the possibility that the insect might have been carried on nursery stock, a record of all the shipments made since July, 1926, was secured and they were traced to destination and examined. This work was done by the Federal force, and cooperation was secured from the inspection departments in many of the States concerned. Of the 3,300 lots of nursery stock that were traced, more than 2,600 were planted on Long Island within 25 miles of North Roslyn. Limited numbers of shipments were sent to the following States: Arkansas, Connecticut, Delaware, Florida, Illinois, Kentucky, Maryland, Massachusetts, Michigan, New Jersey, North Carolina, Ohio, Pennsylvania, South Carolina, Texas, Virginia, Washington, West Virginia, and the District of Columbia.

Live gipsy-moth egg clusters were found and treated on shipments planted in the fall of 1929 as follows: At Interlaken, N. J., 1; at Southold and Douglaston on Long Island, 3 each; and at Glen Cove, Long Island, 1. Several old egg clusters were found on stock planted at Flushing and Long Beach, Long Island; but although the areas surrounding these places were carefully scouted, no live infestation of the gipsy moth was discovered. The area at Interlaken, N. J., has been thoroughly sprayed, and the points where infestation was found on Long Island have been carefully examined and treated by the conservation department of New York.

The cooperative arrangement made with the State of New York provided that the nurseries in Nassau County would be inspected and, if clean, certified as free from the gipsy moth by the Department of Agriculture and Markets, and that in addition to this inspection and certification, all shipments made within a 3-mile radius from North Roslyn, would be examined and, if clean, certified by Federal inspectors before being moved from the property. This arrangement has been followed and 3,234 shipments of nursery stock were inspected and certified up to the close of the fiscal year.

Good progress has been made in handling this infestation, but thorough work will be required over a large area in order to exterminate the insect in Nassau County. Several infestations were found in woodland areas, so that the expense of final extermination in this county will be considerable.

BARRIER ZONE PROJECT IN NEW ENGLAND AND NEW YORK

The scouting and clean-up work in the New York section of the barrier zone have for the most part been handled by the department of conservation of that State. As a result of the work done in the fiscal

year 1929, more infestations were found than during the previous year. The same condition prevailed in the barrier-zone area in southern Massachusetts and northern Connecticut. The barrier zone consists of a strip about 30 miles wide east of the Hudson River. Most of the scouting had been confined to the examination of roadsides, orchards, and small areas of woodland, together with the borders of forest areas fronting on fields, roads, or trails.

It was evident that more systematic work must be done in the dense woodland areas, particularly in that portion of the zone where the number of infested locations was increasing. On account of the ever-present danger of small caterpillars of the insect being brought into this area by wind currents from territory to the eastward where more infestation exists, a plan was put into operation to scout the woodland in as many of the towns as possible in the northern half of the Connecticut and the southern half of the Massachusetts barrier-zone area, together with three towns in Vermont west of Rutland. It was also planned to scout in the usual way a portion of the southeastern section of the barrier zone in Connecticut and in northern Vermont which was not examined during the previous fiscal year.

The woodland scouting was carried through by utilizing men spaced 40 feet apart as they proceeded through these areas. By this plan each man would inspect the trees 20 feet on each side of the line which he was following. It was believed that this would make possible the discovery of any considerable infestations in these woodland areas and that a closer examination was not warranted in a territory which was subject to constant infestation from the east. All infestations that were found were treated in order to prevent the increase of the insect, and after the lapse of two or three years a similar examination will be necessary in this area.

After the work had progressed for a time numerous infested points were found, and it was determined that with the funds available the plan outlined could not be completed and the necessary treatment applied within the fiscal year. Deficiency funds were made available in March so that the work proceeded in accordance with the plans.

On account of the necessity for scouting many towns where the woodlands were inaccessible and conditions usually made travel impossible in midwinter, an arrangement was effected whereby the conservation department of the State of New York carried on scouting work in the towns of Kent, Sharon, and a part of Salisbury, Conn., immediately adjoining the New York State line, in order that the work in these towns might be completed before weather conditions made it necessary to discontinue operations. This was carried out as a cooperative measure and for the protection of the New York territory in the zone. Later in the season an equivalent amount of Federal money was expended in the newly discovered gipsy-moth infestation on Long Island.

During the fiscal year the following areas of woodland were scouted in the barrier zone:

	Acres
Massachusetts-----	205, 030
Connecticut-----	157, 944
Vermont-----	23, 445
Total-----	386, 419

In addition to this work, 18 towns in Connecticut and 20 in Vermont were scouted in the usual manner, and 30 areas where colonies had been found in previous years scattered through all the States in the barrier zone were thoroughly examined.

Table 1 indicates the number of infested locations found in the barrier zone during the fiscal years 1929 and 1930:

TABLE 1.—*Gipsy-moth infested locations found in the barrier zone, fiscal years 1929 and 1930*

Towns	1929	1930	Towns	1929	1930
FEDERAL WORK			FEDERAL WORK—continued		
Vermont, Poultney.....	1	0	Connecticut—Continued.		
Massachusetts:			North Canaan.....	5	1
Becket.....	0	2	Salisbury.....	4	6
Egremont.....	1	0	Sharon.....	0	2
Lee.....	1	0	Warren.....	3	3
Monterey.....	0	1	Wallingford.....	1	3
Mount Washington.....	0	1			
New Marlboro.....	18	42	STATE OF NEW YORK WORK		
Otis.....	4	2			
Sandisfield.....	12	15	New York:		
Sheffield.....	18	17	Claverack.....	1	0
Stockbridge.....	0	1	Copake.....	4	0
Tyringham.....	1	0	Dover.....	(1)	1
Connecticut:			Hillsdale.....	4	1
Beacon Falls.....	(1)	1	Northeast.....	2	0
Canaan.....	6	12	Petersburg.....	1	0
Cornwall.....	2	3	Taghkanic.....	0	1
Fairfield.....	1	0			
Goshen.....	1	0	Total.....	101	120
Norfolk.....	10	5			

¹ No scouting done.

The number of egg clusters found has not been tabulated for the reason that the woodland infestations and the surrounding areas were sprayed and a complete record of the number of egg clusters was not secured.

Weather conditions during early June were unfavorable for spraying and some of the infested locations had to be treated more than once. It was possible to complete all the spraying work shortly after the close of the fiscal year.

During the year infestations have been found by Federal or State men in several towns adjoining the barrier-zone area on the east at Cheshire, Mass., and Meriden, Middlefield, and Branford, Conn. Treatment was applied by the States concerned, the Federal force cooperating. The location of some of these infestations was very favorable for spread into the barrier zone and illustrates the difficulty of keeping the zone free from infestation if similar untreated areas exist in adjoining territory.

QUARANTINE AND INSPECTION WORK

During the year a special form of certificate was used to cover greenhouse-grown florists' stock, the movement of which is not restricted by the gipsy-moth quarantine. Such plants as roses are frequently held or returned by State or transit inspectors when the fact of their greenhouse origin can not be determined from the package. The use of this certificate is not compulsory but has been very useful to shippers in facilitating the prompt delivery of such materials.

During the second quarter of the fiscal year heavy shipments of Christmas trees and greens were certified and upwards of 100 men were required to inspect this material. In the fall of 1929, 15 additional men were required to assist in the inspection of nursery stock, and in the spring of 1930, 25 additional inspectors were used. These needs were met by temporary transfers from the scouting force.

Tables 2 to 4 indicate the volume and kind of products that were inspected and certified during the year:

TABLE 2.—*Evergreen products certified under gipsy-moth quarantine, fiscal year 1930*

Material ¹	Bags	Bales	Boxes	Bundles	Carloads	Packages	Trees
Balsam twigs.....	1					52	
Boughs.....		5,881	114	13	66	12	
Christmas trees.....				1,762	717		45,121
Cut cedar trees.....					1		150
Laurel.....	810	2,085	117	4,668		52	
Mixed greens.....	52		3,541	106		64	
Wreaths.....			387			8	
Total.....	863	7,966	4,159	6,549	784	188	45,271

¹ Of nursery stock there were certified 5,756 cases, 6,961 bales, 13,444 boxes, 352 carloads, 9,583 packages, and 1,797 truck loads.

TABLE 3.—*Forest products certified under gipsy-moth quarantine, fiscal year 1930*

Material	Bags	Barge loads	Boxes	Bundles	Carloads	Cases	Cords	Lots	Pieces	Truck loads	Found infested	Gipsy moth found	
												Egg clusters	Larvæ and pupæ
Barrel parts.....				469	51			4	164				
Crates and cratings.....					10				626		1 piece.....		1
Fuel wood.....	1		2	14	144		70½			12	{ 1 bag.....	11	
Logs.....				2	503	1			123	203	{ 9 bundles.....		
Lumber.....	5	4		13	676	3		138	274	322	{ 1 car.....	2	7
											{ 2 pieces.....		
Piles and poles.....					319				66	37	{ 4 barges.....	912	8
Posts.....				12	14			6	307	3	{ 12 cars.....		
Pulp wood.....					3,594			6		18	{ 1 lot.....	174	
Reels.....					421				8,291	1	{ 1 car.....		
Shavings.....					105						{ 4 cars.....	13	172
Ship knees.....					12				568		{ 30 pieces.....		
Spool stock.....					159								
Ties.....					2,563			1					
Vine and shrub cuttings.....	4		58	16		2					4 cars.....	24	35
Miscellaneous.....	250	2	58	1,276	84	59	1	56	255		{ 2 barges.....	320	
											{ 1 car.....		
											{ 1 piece.....		
Total.....	260	6	118	1,802	8,655	65	71½	211	10,674	596	(²)	1,356	223

¹ This does not include 17 egg clusters found on 3 lots of car stakes.
² Infested total: 1 bag, 6 barges, 23 cars, 9 bundles, 1 lot, and 34 pieces.

TABLE 4.—*Stone and quarry products certified under gipsy-moth quarantine, fiscal year 1930*

Material	Bags	Barge loads	Barrels	Boxes	Carloads	Crates	Pieces	Truck loads	Found infested	Gipsy moths found	
										Egg clusters	Larvæ and pupæ
Crushed rock.....				16	3,038			28			
Curbing.....					305		6		3 cars.....	7	28
Feldspar.....					189			2			
Garnet.....					9						
Granite.....	1	30		84	6,103	1,564	182,129	2	{11 cars - 2 pieces -}	1 20	14
Grout.....					33						
Marble.....			25	34,311	1,545	57,660	13,176	2			
Old iron.....					13						
Paving.....		11		8	769	1			104 cars.....	527	101
Miscellaneous.....	20		1	4	40					(²)	
Total.....	21	41	26	34,423	12,044	59,225	195,311	34	{118 cars - 2 pieces -}	554	143

¹ This does not include 154 egg clusters found on car stakes and crating materials.

² 4 egg clusters were found on car stakes.

The material shown in Table 5 originated outside the gipsy-moth quarantine area and was shipped from points inside of the area under authorized permits:

TABLE 5.—*Shipments under permit from inside of the quarantined area of articles which originated outside of that area, gipsy-moth quarantine, fiscal year 1930*

EVERGREEN PRODUCTS

Material	Bags	Bales	Barrels	Boxes	Bundles	Cars	Cases	Trees
Boughs.....		122			5	5	4	
Boxwood.....	1			23			23	
Christmas trees.....					38	78		319
Holly.....			1	8			39	
Laurel.....	24	4	11	12	159		6	
Mixed greens.....				24				
Total.....	25	126	12	67	202	83	72	319

FOREST PRODUCTS

Material	Carloads	Cords	Lots	Pieces	Truck loads	Wagon loads
Fuel wood.....		40				5
Logs.....	6			50	2	603
Lumber.....	213		6		28	
Poles.....	78					
Pulp wood.....	135					
Spool stock.....	2					
Ties.....	98		1			
Miscellaneous.....	14		3		51	20
Total.....	546	40	10	50	81	628

NURSERY STOCK

Material	Bales	Boxes	Cases	Packages	Truck load
Nursery stock.....	6	26	7	37	1

TABLE 5.—Shipments under permit from inside of the quarantined area of articles which originated outside of that area, gipsy-moth quarantine, fiscal year 1930—Continued

STONE AND QUARRY PRODUCTS

Material	Boxes	Carloads	Pieces
Granite.....		1	26
Marble.....	27	2	0
Total.....	27	3	26

Under the gipsy-moth quarantine regulations materials which have been manufactured, processed, and stored in such a manner that in the judgment of the inspector no infestation could be transmitted, may be moved if accompanied with permits issued to the shipper. During the year the material shown in Table 6 was shipped under these permits which were issued to 125 firms:

TABLE 6.—Shipments under permit of articles manufactured, processed, and stored in such manner that no infestation could be transmitted, fiscal year 1930

Material	Num-ber of firms ship-ping ¹	Barge loads	Car-loads	Disks	Lots	Pieces	Poles	Reels	Tons
Forest products.....	52		992	385	1, 236	318	470	6, 251	
Stone and quarry products..	68	94	1, 222			21, 560			93, 557
Total.....	120	94	2, 214	385	1, 236	21, 878	470	6, 251	93, 557

¹ Firms under permit at the close of the last fiscal year, 125; permits canceled during the fiscal year 1930, 9; permits granted, 4.

In connection with the work in the inspection districts, attention has been given the examination of tourists' camp grounds in order to determine whether trees infested with the gipsy moth were present. Ninety-five were inspected and on 15 of these some infestation was found. Arrangements were made for the proper treatment of these infested camp sites by the owners.

The volume of shipping was considerably greater than during the previous fiscal year and owing to the increase in infestation in the eastern part of the territory, great care was necessary in making examinations before certificates could be issued.

THE BROWN-TAIL MOTH

The brown-tail moth has not spread west of the present quarantine line but more extensive defoliation has been caused by this insect, particularly in southern New Hampshire and southeastern Maine than has been the case in recent years. In many other sections the results would have been similar had not special attention been given to removing the winter webs of the insect and destroying them by burning. In many towns in eastern Massachusetts the local authorities report that a much larger number of webs was destroyed than had been the case during the last few years. Apparently this insect is increasing at the present time and more damage is likely to result unless repressive measures are more uniformly applied.

THE SATIN MOTH

During the summer of 1929 additional information was secured in cooperation with officials of the New England States relative to the injury caused by this insect and areas to which it had spread. This resulted in an addition to the area under quarantine of 38 towns in Maine, 3 in New Hampshire, and 5 in Massachusetts. This insect was very abundant in the spring of 1930 and heavy defoliation of poplar and willow trees resulted. Reports were received from southern New Hampshire and various points in Maine as far north as Bangor, that an unusual number of trees were being attacked. In a number of areas in southern New Hampshire this pest has been found feeding freely on poplar foliage in woodlands, which may forecast heavy losses in the future where this tree is grown for paper pulp.

The Government entomologist of Canada reports that the insect has been found this summer at Annapolis, Nova Scotia.

EUROPEAN CORN-BORER CONTROL

The commercial damage by the European corn borer to the corn crop of 1929 was somewhat worse than the previous year. In New England where two generations occur, considerable damage was evident in northeastern Rhode Island and in the bordering counties in Massachusetts. In the 1-generation area an increase in numbers was evident in northwestern Ohio, and some fields suffered loss from the borer. The most outstanding increases were as follows, expressed as number of larvæ per 100 stalks:

	1928	1929		1928	1929
Monroe County, Mich.....	57.96	85.19	Seneca County, Ohio.....	5.50	29.05
Lucas County, Ohio.....	31.80	146.42	Erie County, Pa.....	6.47	14.10
Williams County, Ohio.....	7.96	51.09	Chautauqua County, N. Y.....	18.54	40.61

There are also several counties in the 1-generation area that have shown decreases and from this fact the area average shows only a slight increase. The infestations shown are, as a whole, well below the level of commercial damage, which begins at about 500 larvae per 100 plants.

Clean-up regulations are being enforced by State authorities in all areas quarantined on account of the European corn borer in the States of Maine, Massachusetts, Rhode Island, and Connecticut, and in sections of Pennsylvania. All of these States with the exception of Pennsylvania have two generations of the European corn borer, and to effect a good clean-up is rather difficult because there are other host plants than corn.

The clean-up work in the States was very good, and in most cases excellent cooperation was experienced with the corn growers and those having flower gardens, etc. The exception to this was in the newly infested areas where people were not familiar with the corn borer and did not clean up as well as those residing in the older infested areas.

The following machinery has been developed for the farmers in the 1-generation area so that good clean-up can be accomplished without a large amount of extra expense or time to the farmer: Low-cutting

corn binders for use at harvest time, plows for completely covering cornstalks, sled cutters for cutting stalks in spring, and rakes for raking stalks into windrows preparatory to burning.

SCOUTING

In addition to the regular scouting work of inspecting cornfields in townships adjacent to the quarantined area, scouting work was conducted in Illinois and Wisconsin, and the cornfields adjacent to the main arteries of travel running out of the quarantined areas in Illinois, Indiana, Ohio, West Virginia, Kentucky, and Pennsylvania, these roads being the most used for long-distance travel. Also, one crew with a flat-bottom boat covered islands and accessible flats along the Ohio River from Marietta, Ohio, to Madison, Ind., and crews were assigned to highways on both sides of the river, inspecting cornfields for the same distance as the river crews.

Two isolated infestations were discovered in this region—one in Ohio Township, Gallia County, Ohio, approximately 30 miles from the nearest quarantined area, and the other in the Goshen district, Oldham County, Ky., about 80 miles from the nearest quarantined area. Isolated infestations were also found in Connecticut, New Jersey, Pennsylvania, and New York.

A synopsis of the scouting is given in Table 7.

TABLE 7.—*European corn-borer infestation record, 1929*

State	Townships found in- fested	Townships found not infested	Area under quarantine at end of the 1929 scouting season	
			1-generation area	2-generation area
	<i>Number</i>	<i>Number</i>	<i>Square miles</i>	<i>Square miles</i>
Connecticut.....	37	92	185. 73	2, 111. 88
Illinois.....	0	31	-----	-----
Indiana.....	106	102	12, 678. 00	-----
Kentucky.....	1	-----	-----	-----
Maine.....	70	45	-----	3, 471. 03
Maryland.....	0	14	-----	-----
Massachusetts.....	7	39	2, 379. 58	5, 240. 02
Michigan.....	59	214	57, 980. 00	-----
New Hampshire.....	11	40	-----	6, 147. 00
New Jersey.....	3	245	71. 29	-----
New York.....	-----	-----	49, 196. 00	8. 00
Ohio.....	135	187	33, 203. 00	-----
Pennsylvania.....	3	185	27, 829. 35	-----
Rhode Island.....	-----	-----	-----	1, 248. 00
Vermont.....	27	42	4, 912. 90	-----
West Virginia.....	10	43	1, 348. 00	-----
Wisconsin.....	0	83	-----	-----
Total.....	469	1, 362	189, 783. 85	18, 225. 93

CLEAN-UP WORK

Clean-up work was done in the following isolated infestations: In Ohio Township, Gallia County, Ohio, 233 acres of corn on 14 farms. In the Goshen district, Oldham County, Ky., a large amount of drift washes ashore and it was necessary to clean 1½ miles of river frontage and 276 acres of corn on eight farms. In Connecticut nine towns were cleaned up. In Pennsylvania, in the townships of Forks, Palmer, and Williams, Northampton County, infestations were found not

contiguous to the quarantined area, and clean-up work was conducted by the State.

In New Jersey, 4 small isolated infestations were found, 2 in the borough of New Milford in Bergen County, 1 in Morris township, Morris County, and 1 in Jefferson Township, Morris County. These infestations were all cleaned up.

In Brooklyn and Staten Island areas, where clean-up work has been conducted since 1925, one specimen was found in Brooklyn and four on Staten Island. There has been a continual reduction each year in this area and clean-up work was conducted this year as previously.

ROAD PATROL

Quarantine stations were located at the border of the quarantined area in both the 1-generation and 2-generation areas in the States of Massachusetts, Connecticut, New York, New Jersey, Pennsylvania, West Virginia, Ohio, Indiana, and Michigan, and also at all ferries running out of Michigan to points outside the regulated area. These stations were located in all important roads leading out of this area and were maintained, in most cases, 24 hours each day. Very little trouble was experienced with the traveling public and only a small number of cars refused to stop. On the heaviest traveled road in the Middle West, U. S. 20, the traffic was handled very successfully. This station was located 55 miles east of Chicago, Ill., at Michigan City, Ind. The week-end traffic was extremely heavy. One hundred and seventy borers were collected at this station in corn that was being carried by autoists the destination of which in many cases was several hundred miles from this station.

The stations located in and around New York City were very difficult to operate owing to the extremely heavy traffic. The stations operated on the border of the 2-generation area collected a much larger number of borers than were collected in the 1-generation section.

The road station operated in Connecticut on United States Highway No. 1 intercepted more specimens than any other point, 940 borers being collected at this point. The traffic on that road was very heavy.

Road stations were operated between the States of New Hampshire and Maine during the entire summer of 1929. A much larger area was found infested in Maine during the scouting season and these stations will not be operated in 1930.

A report of quarantine line work follows.

	Number
Quarantine stations-----	217
Ports of inspection-----	21
Vehicles stopped-----	12, 850, 695
Ears of corn taken-----	391, 249
Corn borers recovered-----	2, 813
Passengers inspected at steamship lines-----	122, 191

In addition to the ear-corn taken the following products and flowers were intercepted, in many instances in large quantities, at the 2-generation area lines: Beans, beets, shelled corn, celery, rhubarb, beet greens, cosmos, gladioli, gladiolus bulbs, asters, Lima beans, zinnias, dahlias, hollyhocks, chrysanthemums, and Sudan grass.

MARKET AND FIELD INSPECTIONS

Market and field inspections in the 2-generation area in New England were conducted as in former years, with inspection stations located at Boston and Worcester, Mass., Portland, Me., Providence,

R. I., and New London, Conn. Also considerable inspection work was necessary in the field at greenhouses and market gardens. Ear corn is not certified for shipment outside of the regulated areas. All other products are certified, providing they are not so heavily infested as to make inspection impractical. The following tabular statement shows the amount of produce and flowers certified or permitted during the 1929 season:

Farm products originating in quarantined area, certified for shipment	bushels	52, 442
Farm products originating outside of quarantined area, permitted for shipment	bushels	111, 509
Cut flowers, plants, roots, and bulbs originating in quarantined area certified for shipment	number	6, 139, 226
Seed, commercial, and pop corn originating in quarantined area, certified for shipment	pounds	7, 727
Seed, commercial, and pop corn originating outside of quarantined area, permitted for shipment	pounds	7, 072, 718
Broomcorn originating outside of quarantined area, permitted for shipment	bales	674
Specimens collected during inspections of farm products, cut flowers, and plants	number	4, 096

INFESTATION SURVEY

An infestation survey was conducted as in previous years. Owing to the fact that counts had been made in every township that showed 1 per cent or more infestation, and the area of infestation had increased to such an extent as to make this impractical, it was deemed advisable to adopt a method where practically the same information would become available at much less cost. The method adopted, therefore, consisted of taking counts in five townships in a county where 1 per cent or more infestation occurred. With the method used counts were made in only 723 townships out of 5,287 infested in the 1-generation area, and 149 townships out of 738 infested in the 2-generation area. Checks were made on this method and it was found that practically the same information was obtained as in previous years when every township was surveyed in the 1 per cent area. Tables 8-10 show the infestation found in this survey.

TABLE 8.—Comparison of corn-borer population and percentage of plants infested throughout the eastern area of New York, western Massachusetts, and western Vermont where the infestation survey was conducted, during the 3-year period, 1927-1929

State	Average percentage of plants infested			Average number of larvæ per infested plant			Total larvæ per 100 plants		
	1927	1928	1929	1927	1928	1929	1927	1928	1929
New York (eastern) ¹	12. 23	9. 02	8. 66	2. 44	1. 62	1. 89	29. 87	14. 60	16. 37
Massachusetts (western)	(²)	(²)	. 97	(²)	(²)	1. 02	(²)	(²)	. 99
Vermont (western)	(²)	(²)	4. 55	(²)	(²)	. 83	(²)	(²)	3. 78
Area average	12. 23	9. 02	8. 25	2. 44	1. 62	1. 87	29. 87	14. 60	15. 43

¹ East of and including Herkimer, Otsego, and Delaware Counties.
² No survey conducted.

TABLE 9.—Comparison of corn-borer population and percentage of plants infested in the 2-generation area (eastern New England) where the infestation survey was conducted during 1928 and 1929

State	Average percentage of plants infested		Average number of larvæ per infested plant		Total larvæ per 100 plants	
	1928	1929	1928	1929	1928	1929
Connecticut.....	2.90	3.91	1.68	1.68	4.87	6.57
Maine.....	2.38	.71	1.12	2.22	2.65	1.58
Massachusetts.....	29.74	44.82	4.61	4.17	137.22	186.90
New Hampshire.....	2.05	7.21	1.65	2.28	3.40	16.44
Rhode Island.....	44.22	54.01	5.69	3.18	251.71	171.75
2-generation area average.....	28.34	37.46	4.77	4.02	135.16	150.59

TABLE 10.—Comparison of corn-borer population and percentage of plants infested throughout the entire area of the Great Lakes section, and for each State, where the infestation survey was conducted, during the 5-year period, 1925-1929

State	Average percentage of plants infested					Average number of larvæ per infested plant					Total larvæ per 100 plants				
	1925	1926	1927	1928	1929	1925	1926	1927	1928	1929	1925	1926	1927	1928	1929
Michigan.....	1.10	3.70	8.90	5.07	4.85	1.36	2.87	3.0	2.21	1.87	1.50	10.73	26.71	11.22	9.07
Indiana.....	(1)	(1)	(1)	.20	.61	(1)	(1)	(1)	1.72	1.15	(1)	(1)	(1)	.35	.70
Ohio.....	1.48	2.17	1.89	3.07	4.73	1.29	2.49	2.02	2.11	2.24	1.90	5.40	3.81	6.49	10.60
Pennsylvania.....	1.28	1.92	3.92	.45	.43	2.08	3.43	2.68	1.81	2.25	2.66	6.59	10.50	.82	.97
New York (western).....	1.56	3.18	2.39	2.88	3.10	2.87	2.20	1.62	1.83	1.98	4.48	7.0	3.87	5.26	6.14
Great Lakes area average.....	1.35	2.95	4.08	3.17	3.76	1.56	2.72	2.58	2.10	2.07	2.11	8.02	10.52	6.65	7.78

¹ No survey conducted.

SPREAD BY STREAMS

Realizing that infested material might be carried into uninfested territory with flood waters originating in the corn-borer area, experiments were started in 1926 to determine how far stalks might be carried by this means. On March 26 of that year, 320 marked units, of which 319 consisted of bundles of stalks, or of separate stalks, and the other of a stubble hill, were thrown into the Ohio River at such points as Constitution, Rockland, Lowell, Yorkville, and Daws, and into the Muskingham River at points north of Marietta, Beverly, and Lowell.

Of course it is impossible in work of this kind to recover all test specimens; but within the 8-week period following the deposition of this material, 32, or 10 per cent, of the original units were found. Pertinent data regarding these recoveries are shown in Table 11.

TABLE 11.—Distance marked material was carried by river waters in spring of 1926

Item	Stalk bundles	Separate stalks	Stubble hill
Units recovered.....number.....	2	29	1
Greatest distance recovered unit had been carried.....miles.....	185	222	58
Least distance a recovered unit had been carried.....do.....	2	0	58

The above data show that infested material can be carried a long distance, and that a sufficient quantity of it actually is carried far enough to present a menace, once stalks are swept into the streams by the water flooding the lowlands adjacent to large streams and their tributaries. The average distance of approximately 44 miles shown by these experiments is a distance nearly twice that of the average flight of moths; then, too, the Ohio River flows in a direction in which spread by moth flight does not seem to be as great, on the average, as it is toward the north and northeast. It is generally conceded that the infestation in Oldham County, Ky., in 1927, originated from infested material in the Ohio River. Parts of the Corn Belt may become infested by spread through the waterways before the insect arrives there by natural flight.

That stalks actually get into the river waters by natural means is common knowledge. During May and June of this fiscal year a few crews of competent men examined drift lodged along the banks of rivers, and stalks caught by trees and bushes which line the streams or stand on previously flooded areas. One crew worked along the Miami River from the vicinity of Dayton to Cincinnati; then east and west from the latter city. Other crews worked on both sides of the Ohio River between Marietta and Cincinnati.

These crews found 25 larvæ and pupæ, 12 of which were living. Most of the specimens were *Pyrausta nubilalis*, but three were *P. nubilalis*. The stalks from which the living specimens were taken were in such excellent state of preservation that there is no telling how far they might have been carried by subsequent high water. None of the corn-borer larvæ were alive; one had been parasitized. It is evident that some of the débris found had come from the infested region.

During the fiscal year a survey was made of the river-bottom areas from western Pennsylvania to Indiana. The object of this survey was to determine approximately the acreage subject to flood from which stalks could be carried by water into the main waterways. Data from this survey are not yet compiled.

At the present time a study is being made of the feasibility of trapping dangerous material in the waterways. The scope of the study also includes the possibility of preventing stalks from getting into fast water at certain points.

From observations made to date it is very evident that the subject of spread of the corn borer by means of waterways is an important one. It is only natural to suppose that the problem becomes more grave as the infestation reaches areas close to those portions of rivers where the currents are most powerful through either speed or volume of water, or both. From this standpoint the infested region in Ohio is dangerously close to the Ohio River. The river problem should continue to receive marked attention because of its possible menace to the great uninfested areas adjacent to the Ohio and to the lower Mississippi Rivers.

JAPANESE-BEETLE QUARANTINE AND CONTROL WORK

SPREAD AND QUARANTINE REVISION

Revisions of the Japanese-beetle quarantine and supplemental regulations were issued early in the spring of 1930 extending the generally infested area to include Harford and Baltimore Counties, the city of Baltimore, and portions of Cecil, Howard, and Anne

Arundel Counties in Maryland; part of Cedar Creek hundred in Delaware; York County, and portions of Adams, Perry, Lycoming, and Lackawanna Counties in Pennsylvania; and Orange and Putnam Counties, and portions of Westchester and Dutchess Counties in New York. Further, a lightly infested area was created including the District of Columbia and two immediately adjacent counties in Virginia; the remaining portion of Maryland excepting the extreme northwestern and southern sections of the State; a small section in southern Delaware; fairly large areas immediately west and north of the generally infested area in Pennsylvania; Dutchess County, except the town of Fishkill, and small sections in Ulster and Broome Counties, N. Y.; the entire remaining portion of Connecticut; and Hampden County in Massachusetts. A total of 43,888 square miles is now under regulation for the insect, 25,595 of which are in the generally infested area and 18,293 in the lightly infested area. This is an increase of only 4,242 square miles in the generally infested area over the regulated area for 1928, or an addition of less than 20 per cent. This is a comparatively moderate increase compared to the actual increase of generally infested territory within the past four years.

The extension of territory included all known infestations with the exception of those in Norfolk and Cape Charles, Va.; Providence, R. I.; and Boston, Mass. Since these points are remote from other infestations they have been permitted to remain as separate control units, Federally supervised under State quarantine authority for the purpose of attempting additional clean-up operations to control the infestations, by keeping down the beetle population if possible.

Scouting activities during the summer of 1929 resulted in the discovery of new infestations of the Japanese beetle in Providence, R. I.; Willimantic, Conn.; Kingston, Newburgh, Beacon, and Binghamton, N. Y.; Athens, Williamsport, Montoursville, Duncannon, Wrightsville, and Chambersburg, Pa.; Warwick, Chestertown, Oxford, and Federalsburg, on the eastern shore of Maryland, Belair, Aberdeen, Forest Green, Havre de Grace, Rosedale, Parkville, Halthorpe, West Elkridge, Colgate, Dundalk, and Sparrows Point, in comparatively close proximity to Baltimore on the western shore of Maryland, also Brunswick, Md.; and Norfolk and Cape Charles, Va.

Infestations discovered during the season of 1928 at Boston and Springfield, Mass., New London and Hartford, Conn., Sayre, Lewistown, and Gettysburg, Pa., Hagerstown, Baltimore, Cambridge, and Delmar, Md., Milford and Delmar, Del., Washington, D. C., and Alexandria, Va., were confirmed by additional scout finds during 1929. At Springfield, Mass., beetles were recovered in noticeably fewer numbers than the previous year. As in 1928, a single beetle only was collected at Lewistown, Pa. Beetles were again located at York, Pa., after a year's lapse during which the infestation had apparently disappeared. At all other of the above-mentioned points of known infestation a notable increase in beetle population was observed.

While the extension of the Japanese beetle regulated area during the year resulted in an increase of 22,535 square miles in the total area under regulation, the greater portion of the increase was occasioned by the inclusion in the newly created lightly infested area of the isolated points of infestation which during the past year were treated as separate control units exempt from Federal quarantine

action. The decision to extend the quarantine restrictions to the separate control units resulted principally from the determination of increased beetle population in these localities despite preliminary clean-up operations, and, in addition, the discovery of infestations in near-by cities, creating a condition of spotted infestations fairly contiguous to the zone of general infestation. The movement of restricted farm products, nursery and ornamental stock, sand, soil, earth, peat, compost, and manure from the generally infested area to points in the lightly infested area is permitted only under provisions applicable to similar shipments destined to points outside either regulated area. This accomplishes the protection of the zone designated as lightly infested from the infestations likely to result from the free movement of beetle-laden articles from the generally infested area, while at the same time permitting the complete regulation of restricted articles emanating from points in the area of light infestation.

NURSERY AND GREENHOUSE SUPERVISION

Authorization for the field treatment of nursery stock with powdered arsenate of lead as a basis for subsequent certification was one of the new developments in the nursery-certification work during the year. The required procedure calls for the incorporation in the upper 3 inches of the soil in nursery rows or about individual plants of powdered lead arsenate at the rate of 1,500 pounds per acre. All stock treated in this manner for shipment during the following fall, winter, or spring must be treated before August 1. Grub diggings to determine freedom of the treated soil from infestation are made in the fall before any plants are dug for shipment. Certification is then granted for the shipment of the stock during the period October 15 to June 15 following the application of the treatment. Treatment in subsequent years is based on the amount of the treating material determined by soil analyses as necessary to be incorporated in the soil to raise its lead arsenate content to the equivalent of 1,500 pounds per acre. This quantity has been determined as the lethal dosage which may be applied without injury to plant growth. During July and August, 1929, and June, 1930, areas upon which 644,229 plants were growing, were treated in accordance with this procedure.

Approximately 1,300 nursery, greenhouse, and other establishments dealing in plants and plant products fulfilled the requirements for classification under the quarantine regulations. Two hundred and seventy of these establishments were in infested areas, 356 in close proximity to infestations, and 674 were in territory uninfested locally. The supervision of nursery and greenhouse scouting, inspection, and certification was directed through 13 sub-offices scattered throughout the regulated areas.

Certification was granted during the fiscal year for the movement of 97,788,480 plants to points outside the regulated areas. Large quantities of these were shipped free from soil, while 28,664 plants were treated with carbon disulphide and 45,123 with hot water. During the same period, 23,446 boxes of cut flowers were shipped under certification. In addition, 17,150 carloads of sand, soil, and earth, 2,156 carloads of compost and manure, and 760 carloads of peat were certified after compliance with the regulations.

Provision was made in the regulations effective March 1, 1930, for the exemption of certain additional bulbs from certification. Previously the exemption applied only to smooth bulbs of tulip, hyacinth, gladiolus, and narcissus. Under the modified regulations, however, all true bulbs, corms, and tubers, when dormant, without fibrous roots and free from soil, are exempt from the requirements of certification, except that this exemption does not apply to dahlias.

QUARANTINE ENFORCEMENT

At the beginning of the fiscal year, 33 road-inspection posts were in operation. These continued with full personnel through August 31. The Delaware posts were abandoned after the first week in September. Four posts in New York were operated until early in November. The organization of the patrol was precisely as in previous years, 24-hour inspection service having been maintained on the principally traveled highways, with fewer shifts and staggered hours in effect on lesser-traveled roads.

Data gathered at the road-patrol stations during the period June to November, inclusive, show that 40,501 cars transporting restricted articles were stopped for inspection, over one-third of which were found to be transporting quarantined articles for which no certificate had been issued. Under authority of the plant quarantine act the majority of these uncertified articles were confiscated by the inspectors. In numerous instances the owners returned to the regulated area with the material or left the same at the inspection post to be picked up on the return trip.

Transit inspection by inspectors connected with the Japanese-beetle project of shipments en route via railway express and the United States mails was somewhat curtailed during the year because of the organization of this work as a separate administration project. Two transit inspectors were maintained throughout the year to cover the parcel-post terminals and railway-express platforms in Philadelphia. One inspector was stationed at the railway-express terminal at Long Island City, N. Y., from July to November, and was then assigned to duty in the New York City post offices from December to March. Another inspector was assigned to the principal railway-express terminals in New York City during the fiscal year, and in addition covered the Long Island City express terminal from April to June.

Convictions secured for five violations of the plant quarantine act arising from shipments made contrary to the Japanese-beetle and Asiatic-beetle quarantine regulations netted total fines of \$1,560. One of the cases, consisting of the shipment of 7 carloads of soil in violation of both these quarantines, constituted one of the most serious infractions of a Federal plant quarantine ever brought to the attention of the administration and resulted in a fine of \$1,400, the largest fine on record for a violation of the plant quarantine act.

During the fiscal year, a total of 683 shipments representing apparent violations of the Federal or State Japanese-beetle quarantine regulations was intercepted while en route to points outside the regulated areas. Investigations through personal calls by inspectors on the shippers and agents of the common carriers concerned were made in the case of 669 of these shipments. Almost without an exception of any consequence, the return of the uncertified articles

to the regulated areas was accomplished, either through directed return by common carriers or voluntary return or abandonment of the articles brought to the road-inspection posts. Parcel-post shipments accounted for 466 of the apparent violations, 108 were intercepted while en route via railway express, 81 interceptions were made at road-inspection posts, 18 at wharves or aboard steamships, 9 while being transported by freight, and a single uncertified shipment was confiscated from the personal baggage of a railway passenger.

Letters of warning were addressed by the administration to all classified establishments or commercial dealers who were found to have violated the regulations. In the prosecutions which were terminated during the year, letters of this nature were found to be of material assistance in demonstrating to the court the administration's policy of extending leniency through the issuance of a friendly warning to violators for their first offense.

CONTROL OPERATIONS

Powdered arsenate of lead was applied as a top-dressing to the turf and soil areas in and about the sites of 12 important isolated infestations. Such treatments were applied during the fall of 1929 and the spring of 1930 at Norfolk and Cape Charles, Va.; Sayre and Athens, Pa.; and Binghamton, N. Y. Spring treatments were applied at Kingston, N. Y.; Hartford, Willimantic, and New London, Conn.; Providence, R. I.; and Springfield and Boston, Mass., during 1930. A mixture of 4 parts of sand, 2 parts of tankage, and 1 part of powdered arsenate of lead was used as the treating material. The sand was employed to furnish bulk and to act as a carrier, while the tankage was utilized for its fertilizing value in offsetting any possible injury resulting from the application of the lead arsenate. The mixture was applied in practically all cases at the rate of 1,500 pounds per acre in order to secure a dosage of approximately 214 pounds of the arsenate of lead per acre (equivalent to 5 pounds per 1,000 square feet of ground surface).

Results of the first season's trap-control work tend to indicate that the extensive use of traps may be of some effect in reducing beetle population at isolated points of infestation. Approximately 18,000 traps were placed during the summer of 1929 in the vicinity of known infestations at Hartford, New London, and Willimantic, Conn.; Delmar and Milford, Del.; Washington, D. C.; 21 localities in the general vicinity of Chesapeake Bay in Maryland; Boston and Springfield, Mass.; Gettysburg, Lewistown, Sayre, Williamsport, and York, Pa.; Providence, R. I.; and Alexandria, Ballston, Cape Charles, Lyon Village, and Norfolk, Va. In addition, trap routes were established in Buffalo, N. Y. and Pittsburgh, Pa., with the object of determining whether any infestations were present. The trap tenders supplemented their trap collections by hand scouting. In all, slightly over 26,000 beetles were recovered in the cities in which traps were located, more than 18,000 of which were trap collections.

Upon the recommendation of the research laboratory of the Bureau of Entomology, the geraniol and eugenol content of the bait used in the traps is being quadrupled for the season's work in 1930. Experiments have demonstrated that this increase in these attractive essential oils of the bait increases the efficiency of the traps by 159 per cent.

Estimates based on the results of the season's work indicate that the operating cost, exclusive of the cost of the traps, is \$36.50 per week for a route of 250 traps, including labor, supervision, transportation, storage, and three trap baitings during the season.

Next season's trap results will furnish comparative data from which some idea may be gained of the efficiency of traps, combined with other control measures, in reducing Japanese-beetle population.

FARM PRODUCTS QUARANTINE

Restrictions on the movement of farm products from the regulated area were effective from June 15 to September 24, inclusive. Toward the latter part of September, it was determined that the adult beetles had disappeared to such an extent that they were no longer found infesting farm products. Accordingly, effective on and after September 25, the restrictions on farm products were lifted for the season.

The expected annual heavy flight of Japanese beetles in the market and river-front districts of Philadelphia, when the insects were present on the wing in large numbers, began on July 8 and continued through August 15. During this period inspection service was available only between the hours of 8 p. m. and 10 a. m. daily, except Saturday and Sunday. On the latter days no inspections were made between 10 a. m. Saturday and midnight Sunday as there was then little demand for inspection service.

In cooperation with the borough of Hammonton, N. J., the administration constructed an approved fumigation house for the fumigation of berries. Preparatory to their certification for movement to points outside the regulated areas, 10,228 crates of raspberries and blackberries were fumigated with carbon disulphide during August, 1929, and June, 1930.

Inspection service was provided at 38 designated farm-products inspection centers scattered at strategic points throughout the regulated areas of Delaware, Pennsylvania, New Jersey, New York, and Connecticut. Specially constructed inspection platforms were erected at Scranton and Philadelphia, Pa., New York City, and Bridgeport and New Haven, Conn.

During the effective period of the farm-products quarantine, 7,149,650 packages of fruits and vegetables, and 39,759 bales of hay, straw, and moss were moved from the regulated area under certification.

STATE COOPERATION

Excellent cooperation has been extended in the enforcement of the quarantine and the application of control measures by the cooperating states of Connecticut, Delaware, Massachusetts, New Jersey, New York, Pennsylvania, Rhode Island, Virginia, and Maryland, and by the city park departments of Springfield and Boston, Mass., and Hartford, Conn.

ASIATIC-BEETLES QUARANTINE WORK

As a result of intensive scouting work performed during the summer of 1929, infestations of *Aserica castanea* were discovered at Cromwell, Ellington, Manchester, Mansfield, New Canaan, New London, and Southport, Conn.; Amawalk, Fishkill, and Kingston, N. Y.; Atlantic Highlands, Eatontown, and Menlo Park, N. J.; Roxborough, Pa.; Berlin and North Chevy Chase, Md.; Milford, Wilmington, and

Winterthur, Del.; and East Falls Church, Va. Infestations of *Anomala orientalis* were found at Bridgeport, Conn., and Schenectady, N. Y.

The quarantine relating to these two beetles was revoked on February 20, 1930, when the Secretary of Agriculture made the following announcement:

NOTICE OF LIFTING OF ASIATIC BEETLE AND ASIATIC GARDEN BEETLE QUARANTINE

(Effective on and after March 1, 1930)

The fact has been determined by the Secretary of Agriculture, as a result of investigations and surveys, that the habits and economic status of the Asiatic beetle (*Anomala orientalis* Waterhouse), and the Asiatic garden beetle (*Aserica castanea* Arrow), on account of which insects Notice of Quarantine No. 66, with regulations, was promulgated March 2, 1929, effective March 15, 1929, and which covered the entire State of New Jersey, the entire District of Columbia, and certain portions of the States of New York, Connecticut, Pennsylvania, and Virginia, do not warrant the maintenance of a Federal quarantine on account of these two insects. Both insects can be effectively controlled by methods and materials now available for the treatment of lawns and grass plots, and, so far as known, the principal injury by *Aserica castanea* and the sole injury by *Anomala orientalis* is to lawns and grass plots.

Now, therefore, I, Arthur M. Hyde, Secretary of Agriculture, under authority conferred by the plant quarantine act, approved August 20, 1912 (37 Stat., 315), as amended by the act of Congress, approved March 4, 1917 (39 Stat., 1134, 1165), do hereby remove and revoke the quarantine placed by said Notice of Quarantine No. 66 upon the District of Columbia, the State of New Jersey, and portions of the States of Connecticut, New York, Pennsylvania, and Virginia and do also hereby revoke the rules and regulations supplemental thereto, such revocation to take effect on March 1, 1930.

PINK BOLLWORM

The most important development in the pink-bollworm situation was the discovery of this insect in the Salt River Valley of Arizona. About 144,000 acres of land are planted to cotton in this valley and around 100,000 bales are produced annually. Two varieties of cotton are grown—upland, mainly Acala, and Pima or Egyptian. The soil is exceptionally fertile, and is watered largely from the Roosevelt Dam Reservoir, located some 65 miles above Phoenix on the Salt River. The cultivated area of this valley begins about 25 miles east of Phoenix and extends about 40 miles west of that city, the average width being perhaps 20 miles. The altitude is around 1,000 feet and the climate is subtropical, thus making conditions almost ideal for the pink bollworm.

The initial infestation was found on October 24, 1929, in gin trash, at Gilbert; from there it was traced to a field 5 miles east, in the extreme eastern end of the cultivated area. This particular area, consisting of some 3,000 to 5,000 acres, was found to be very heavily infested, from 50 to 75 per cent of the green bolls then remaining in the field containing live pink bollworms. The infestation gradually diminished in intensity from this point and, when finally delimited, was found to extend about 10 miles into the cultivated area, the most westerly infested field being about 2 miles west of Chandler. Approximately 40,000 acres of cotton are involved in the infestation.

On October 30, 1929, the pink-bollworm quarantine was amended, effective October 31, to include the counties of Maricopa and Pinal, in Arizona, within the area designated as "regulated."

Shortly after the infestation was discovered, the Arizona authorities issued orders prohibiting the movement of unsterilized cottonseed

from any gin in the Salt River Valley. Construction of sterilizers was begun immediately. Arrangements were made whereby cotton lint would be shipped to Tucson and El Paso for fumigation, after it had been compressed locally. Construction of a vacuum fumigation plant at Phoenix was started immediately. All of the above machinery was in operation within a period of about 30 days.

After delimiting the infestation, all shipments of cotton products which might spread infestation were traced. Comparatively few such shipments had been made. Fortunately, no freight cars had been used during the 1929 season in hauling cottonseed from the infested area to oil mills; such seed was apparently hauled in trucks.

A public hearing was held by the Arizona State Commission of Agriculture and Horticulture at Phoenix on January 6, 1930, to consider the establishment of noncotton zones. Following this hearing and in accordance with the State law two such zones were declared on January 9, 1930. These noncotton zones included all the known-infested area and 2 miles beyond the outermost known-infested sections. In addition to the noncotton zones a restricted or protective zone was established, extending 3 miles beyond the noncotton zones. In this restricted zone cotton was allowed to be planted only after April 1 for Pima and April 20 for upland varieties. The noncotton zones total 134,400 acres in extent, and the restricted zone covers 205,440 acres surrounding them.

Prior to and coincident with this, steps were taken to inaugurate a fully effective eradication campaign, including the clean-up of fields and the destruction or sterilization of all crop remnants likely to harbor the pest. Arizona had no basic law which provided a method of compensating farmers deprived of the right to grow cotton. Since the State legislature was not in session and as such a law could not be enacted without great delay, the Federal Congress modified the basic joint resolution authorizing Federal compensation for actual and necessary losses sustained by farmers within a noncotton zone. This modification retained the principle of compensation on a 50-50 basis, but provided that the entire compensation would, for the crop season 1930, be paid by the Federal Government. This important and unusual exception was, however, conditioned on the repayment, by the State, or associations, corporations, or individuals, into the Federal Treasury of one-half of the amount expended by the United States in the State. The amended legislation, which was approved February 8, 1930, also authorized an appropriation of \$2,500,000 and placed upon the Secretary of Agriculture the responsibility of determining the actual and necessary losses of any farmer incident to the enforcement of the noncotton zone.

In order further to meet the emergency and provide funds for necessary clean-up, Congress, by joint resolution, also appropriated \$587,500. This appropriation was approved February 7, 1930, but stipulated that no expenditures should be made from it until a sum sufficient to compensate any farmer for one-half of his actual and necessary losses had been appropriated by the State of Arizona or guaranteed to the satisfaction of the Secretary of Agriculture.

Various associations and corporations in or doing business within the State of Arizona signed guaranties pledging to repay into the Federal Treasury \$498,000. These guaranties were accepted by the Secretary on February 24, and at that time he authorized the use of

funds appropriated for cleaning the fields. The active work of field clean-up was immediately begun.

Headquarters had already been established at Mesa, Ariz., and inspectors and clerks thoroughly familiar with necessary operations had been selected from the permanent force of pink-bollworm employees and transferred to the scene of activities. These employees served as a skeleton for the temporary organization and were under the immediate direction of Sidney D. Smith.

In the field clean-up the method of procedure consisted in first cutting the cotton stalks with mowing machines, having heavy cutter bars attached, and raking them into piles with horse rakes. Heavy garden rakes were then used to collect such débris as the rakes would gather; following this came large crews with cotton sacks and hand-picked the fields. All the material collected was then completely burned. Fortunately, labor was plentiful and this work was completed by the end of April. Approximately 47,150 acres were cleaned, 36,124 acres in the noncotton zone and 11,026 acres in the restricted area, at an average cost of \$8.85 per acre. This cost does not include the technical supervision, but merely the labor engaged in the actual clean-up operations and the necessary equipment.

In the Salt River Valley, it is customary to grow cotton from stubs, without replanting, for four or five years. This method requires less water than that of preparing the ground and planting. Very little land was plowed before and during the clean-up campaign, consequently a large part of this acreage sprouted a fair stand of stub cotton. It was necessary, in order to complete the eradication measures started, to destroy all this stub cotton. This work was begun immediately following the completion of the field clean-up and was completed early in June.

The occurrence and abundance of the volunteer, or stub, cotton at first seemed very disconcerting. Eventually, however, it may prove to be an aid in the eradication as it has served as a trap for the moths emerging from larvæ that were in the ground and thus had not been destroyed by the field clean-up. All of the first growth of stub cotton was destroyed prior to the time the new lot of worms developed sufficiently to leave the cotton.

The field work in this program of eradication was supported by results of daily investigations of the activities of the insect. The Bureau of Entomology cooperated with the administration in carrying out these tests. Flight screens were set up at strategic points to give a record of moth activities. Soil-screening tests were conducted to determine the number of worms still living in the ground and the rate of pupation, from which an idea of the rate of emergence could be obtained. A large system of trap plantings was used as the stub cotton was being destroyed. These trap plantings consisted largely of stub cotton, which was stripped of all fruit every 18 days until such time as the danger was apparently passed, and then destroyed.

There was practically no mortality of the pink bollworm in the fields in this area during the past winter. Taking into consideration the climate, the intensity of infestation, and the methods of growing cotton, there is probably no area in the United States where the eradication of the pink bollworm would be more difficult than in the Salt River Valley. Consequently, every possible effort has been

and will continue to be put forth that will tend to bring about success in this undertaking.

As indicated above, the amended act authorizing compensation placed on the Secretary of Agriculture the responsibility of determining the compensation of the actual and necessary losses to farmers within the noncotton zone. It also provided that he should prescribe necessary regulations to govern the determination of the amount and conditions under which compensation would be paid. Such regulations were promulgated on April 9, 1930, and among other things provided for the establishment of a compensation claim board, the board to be composed of three members, one of whom is an officer of the Plant Quarantine and Control Administration and the other two are residents of the State in which the noncotton zone was established. Such a board was appointed by the Secretary on April 24, 1930, and consisted of R. E. McDonald, chairman, Fred Tait, and C. Warren Peterson.

SITUATION AS TO OLDER AREAS OF INFESTATION

Intensive field inspection failed to reveal any trace of the pink bollworm in the Pecos Valley of New Mexico and the western extension of Texas. One infested field was found in the Mesilla Valley of New Mexico and also one in the Safford area in Arizona. The field in the Safford area was quite a distance from the main cotton-growing section in this area and not over 100 acres in the immediate vicinity of the infested field had been planted to cotton. Although no infestation was found in the field in the Pecos Valley of Texas, two specimens were found in gin trash at the gin in Balmorrhea. Larvæ were also found in gin trash in the El Paso Valley of Texas and the Juarez Valley of Mexico. In the Big Bend section of Texas the infestation seems to have been unusually heavy, certain fields showing practically 100 per cent infestation before the end of September. It will be remembered that for the crop season of 1928 a noncotton zone was maintained in part of the Big Bend area—Brewster County—consequently the cotton in this county was watched with particular interest. The pink bollworm reappeared in that county, and by the middle of September, 1929, the infestation had reached about 2 per cent. Infestation in other parts of the Big Bend, however, either increased in intensity or remained practically the same as for the preceding year.

ANNUAL SURVEY IN THE EL PASO VALLEY

Intensive inspections have been made on the Ivy-Dale ranch, in the El Paso Valley, each year since 1920, to determine the extent to which the infestation has varied from year to year. This farm seems to present an average condition for the valley and has been regularly planted to cotton. The altitude in this locality is 3,500 feet and cotton is frequently subjected to early frost damage. Full control methods, such as gin-trash disposal, seed sterilization, compression, and fumigation of lint, have been in effect for a number of years. Following each crop, inspections amounting to 54 man-days have been made. The results of this season's and previous surveys are given in Table 12.

TABLE 12.—*Annual fluctuations of pink-bollworm infestation in the El Paso Valley, 1920–1929*

Crop year	Month of scouting	Specimens collected			Crop year	Month of scouting	Specimens collected		
		Alive	Dead	Total			Alive	Dead	Total
1920	December	0	5	5	1925	December and January..	0	252	252
1921	do	3	155	158	1926	January and February..	0	2	2
1922	December and January..	11	63	74	1927	January	1	11	12
1923	January	0	0	0	1928	February	0	0	0
1924	January and February..	0	3	3	1929	January	0	0	0

SCOUTING IN ALL AREAS

Field scouting is conducted each year for the purpose of locating any new infestations of the pink bollworm, and of determining the status of this pest in areas where control and eradication measures have been applied. There is a constant danger of infestation being brought from Mexico, especially by Mexican laborers; this condition exists to a greater extent in the lower Rio Grande Valley of Texas than elsewhere, since cotton production is more or less continuous from this region into the Cotton Belt proper. In past seasons the scouting has been confined largely to the American side in this area, very little attention being paid to the Mexican plantings. During the 1929 season, however, a very thorough inspection was made of the Mexican plantings, 520 man-days scouting being performed as compared to 56 man-days for the previous season. A total of 1,438 man-days scouting was done in the lower Rio Grande Valley, on the American and Mexican sides combined. A total of 2,255 man-days inspection was made outside of any areas known to have been infested. Of the above scouting, 232 man-days were devoted to western Arizona, 649 man-days to eastern California, and 152 man-days to Lower California; these latter inspections were considered advisable because of the findings in the Salt River Valley, previously discussed. A general inspection was made in the States of Louisiana, Mississippi, Alabama, Georgia, Florida, and South Carolina, requiring 161 man-days. The results in all the above inspections were negative. Very little scouting was done in the old eradication areas, the results of previous years' scouting having established that the pest has apparently been eradicated from these areas. Table 13 lists all the localities where scouting was done following the crop year 1929 together with that done during the four preceding years. The results of scouting for the crop years between 1917, the year the pink bollworm was first discovered in the United States, and 1926, will be found in the Annual Report for 1927.

TABLE 13.—Summary of field scouting for the pink bollworm for crop years 1925–1929

Area and district	1925		1926		1927		1928		1929	
	Man-days	Infestations found	Man-days	Infestations found	Man-days	Infestations found	Man-days	Infestations found	Man-days	Infestations found
Old eradication areas:										
Hearne, Tex.	0	0	0	0	0	0	0	0	0	0
Trinity Bay, Tex.	787	0	828	0	1,025	0	97	0	14	0
Ennis, Tex.	606	0	566	0	842	0	11	0	28	0
Marilee, Tex.	237	0	283	0	418	0	20	0	9	0
Cameron, La.	649	0	661	0	533	0	0	0	0	0
Shreveport, La.	606	0	568	0	781	0	0	0	9	0
Infested areas:										
Pecos Valley, N. Mex. ¹	626	16	97	0	126	2	0	0	366	0
Pecos Valley, Tex.	183	22	32	8	1	6	74	2	341	(2)
Mesilla Valley N. Mex.	155	0	47	2	303	6	76	0	42	1
Mesilla Valley, Tex.	17	1	1	2	0	0	6	0	0	0
El Paso Valley, Tex.	131	14	114	4	55	2	54	0	128	(2)
Juarez Valley, Mexico.	2	3	27	0	0	0	18	0	0	(2)
Big Bend, Tex.	(3)	96	(3)	(4)	(3)	(4)	(3)	(4)	(3)	(4)
Big Bend, Mexico.	0	0	(3)	(4)	(3)	(4)	(3)	(4)	(3)	(4)
San Carlos, Monclova, Mexico.	37	0	36	2	0	0	14	0	0	0
Deming, N. Mex.	15	0	34	3	2	1	103	0	100	0
Duncan Valley, Ariz. and N. Mex.	0	0	71	1	9	3	156	0	90	0
Gila (Safford) Valley, Ariz.	28	0	262	4	7	3	175	0	103	1
Cochise County, Ariz.	11	0	160	10	20	4	21	0	0	0
Santa Cruz Valley Ariz. ⁵	197	0	339	0	454	1	85	0	38	0
Western Extension, Tex. ⁶					850	24	1,790	1	1,425	0
Salt River Valley, Ariz. ⁷									1,359	33
Suspicious areas:										
Uninfested western extension, Tex.	746	0	967	0	1,684	0	2,000	0	99	0
Lower Rio Grande, Tex.	886	0	671	0	592	0	974	0	918	0
Lower Rio Grande, Mexico.	16	0	15	0	8	0	56	0	520	0
Other areas ⁸	436	0	1,198	0	926	0	2,809	0	2,255	0
Total	6,371	152	6,977	36	8,636	52	8,539	3	7,844	35

¹ Infestation in this valley prior to 1925 was confined to Carlsbad and vicinity, and is referred to in certain previous reports as "Carlsbad infestation."

² Infestation found in gin trash but not in the field.

³ Research examinations.

⁴ Heavy infestation; exact number of fields not recorded.

⁵ Includes plantings extending from Red Rock, southward to Nogales.

⁶ Inspections for 1925 and 1926 included in "Uninfested western extension."

⁷ Inspections for years previous to 1929 included in "Other areas."

⁸ Covers scouting done at other points outside the regulated area some of which are, for various reasons, under some slight suspicion.

SPECIAL SCOUTING IN MEXICO

To obtain necessary information on the occurrence, abundance, and hosts of the pink bollworm in Mexico, a cooperative project was organized by the administration and the Oficina para la Defensa Agrícola, of the Mexican Department of Agriculture, to make a preliminary survey of the northern half of the Republic of Mexico. This survey was made during the period September, 1929, to March, 1930. Particular attention was given to determining the distribution and importance of the malvaceous plant, *Hibiscus cardiophyllus*, as a host of the pink bollworm in that area between the Laguna and the border as well as in certain other localities where the growing of cotton, at one time known to be infested, had been abandoned. Light infestations of this plant in past seasons, in mountains just north of the Laguna, indicated that it might be an important factor in carrying the insect over periods when no cotton was grown. Because of a prolonged drought in the area inspected, there was very little fruit on the plants and the results of the survey were not conclusive.

The survey did, however, indicate that *Hibiscus cardiophyllus* is distributed generally throughout the State of Coahuila and in parts

of Chihuahua and Nuevo Leon. Other malvaceous plants, including *Abutilon hypoleucum*, were also found to be widely distributed, and one pink bollworm was taken from fruit of this plant in the State of Coahuila. All other examinations of malvaceous plants were negative. The plants of *A. hypoleucum* seemed to thrive best in narrow, rocky canyons where there is considerable shade, although they were found in various other locations. In regard to cotton plantings, the results were negative, except in the States of Chihuahua, Coahuila, and Durango. Pink-bollworm infestation was found in all cotton plantings in these States, with the exception of the border plantings in Coahuila.

This survey was performed by 8 inspectors of the administration and 4 to 12 inspectors from the Mexican department. An excellent spirit of friendliness and cooperation existed between the men; they were treated with courtesy and given all assistance possible by officials and others with whom they came in contact.

CONTROL MEASURES

The most important safeguards required to control and prevent the spread of the pink bollworm from the infested areas of west Texas, New Mexico, and Arizona are (1) disposal of gin trash, (2) sterilization of seed, (3) supervision of oil mills handling seed produced in infested areas, (4) fumigation and compression of lint, and (5) road-inspection stations.

DISPOSAL OF GIN TRASH

A considerable amount of trash is removed from cotton in the process of ginning; many pink bollworms are discharged with this trash in infested areas. This trash is disposed of daily by burning, sterilization, or grinding. The importance of the examination of gin trash as an adjunct to field inspection was discussed in the last annual report.

SEED STERILIZATION

All gins in the regulated areas are equipped with seed sterilizers, through which the seed passes as a continuous process of ginning. The seed is heated to a temperature of 145° F., the sterilizer being equipped with a thermograph so that a continuous record is made. These machines are checked daily to see that they are operating properly. During the season, 204 machines sterilized 146,800 tons of cottonseed at an average efficiency of 95.2 per cent, the highest record yet made. The record of the 65 sterilizers, constructed in the Salt River Valley, is included in the 95.2 per cent, which shows that they immediately started operating at a high rate of efficiency.

SUPERVISION OF OIL MILLS

As in previous years the movement of seed from regulated areas is prohibited, except where there is a lack of available oil mills. The absence of oil mills in certain areas again made it necessary to license, for the 1929 season, certain mills outside the area. These mills were located at Colorado, Sweetwater, Abilene, Lubbock, and Slaton, Tex. They were operated under the same requirements as for the preceding season; namely, seed was hauled to them in sealed cars, unloaded, segregated, and crushed during the winter or early spring, the crushing being completed prior to May 1, 1930. Cars hauling seed to

mills, either in or outside regulated areas, were always cleaned thoroughly before being released. Seed was required to be crushed so as to destroy all pink bollworms. Seed, linters, and grabbots were segregated to prevent contamination of finished products, until treated in accordance with the regulations. During the season, approximately 140,000 tons of seed were crushed under supervision. The mills were thoroughly cleaned at the end of the season.

LINT FUMIGATION

There are 11 vacuum fumigation plants operated under supervision in the regulated areas, one plant being located at each of the following points: Phoenix and Tucson, Ariz.; El Paso, Marfa, Big Spring, and Lamesa, Tex.; and Roswell, N. Mex. Fabens, Tex., and Las Cruces, N. Mex., have two plants each. Table 14 shows the amount of cotton fumigated at these plants for the 1929 season:

TABLE 14.—*Cotton lint and linters fumigated, 1929 crop*¹

Location of plant	Lint	Linters	Total
	<i>Bales</i>	<i>Bales</i>	<i>Bales</i>
Big Spring, Tex.....	58,602	1,586	60,188
Lamesa, Tex.....	32,258	1,117	33,375
Marfa, Tex.....	4,524	281	4,805
Fabens, Tex. (2 plants).....	36,802	2,506	39,308
El Paso, Tex.....	6,442	2,049	8,491
Roswell, N. Mex.....	42,277	1,845	44,122
Las Cruces, N. Mex. (2 plants).....	46,887	139	47,026
Tucson, Ariz.....	27,591	1,434	29,025
Phoenix, Ariz.....	68,974	3,121	72,095
Total.....	324,357	14,078	338,435

¹ 400 bales of Mexican lint and 385 bales of Mexican linters are included in above figures.

ROAD STATIONS

Traffic-inspection stations were maintained throughout practically the entire season at strategic points on highways leading out of regulated areas for the purpose of intercepting any cotton products likely to spread infestation. These stations were located at the following points: Gail, Coahoma, O'Donnell, Sterling City, Fort Stockton, Girvin, Alpine, Fort Davis, and Valentine, Tex.; Tucson and Sentinel, Ariz.; Lordsburg, Lovington, and Roswell (two stations), N. Mex.

The two stations at Roswell were necessary to guard the two main highways leading eastward from the Pecos Valley. The station at Lordsburg intercepted eastbound traffic for products likely to carry the *Thurberia* weevil; and westbound traffic for products likely to carry the pink bollworm. The station at Sentinel, Ariz., was opened on January 20, 1930, and was taken over by the State of Arizona on February 17, 1930. In addition to the station mentioned above the State of Arizona operated a number of other stations. During the year, 587,994 vehicles were inspected at the Federal stations and 16,654 confiscations made of products moving in violation of the pink-bollworm and *Thurberia*-weevil quarantines. Any article which could be cleaned or disinfected was so treated and allowed to proceed; otherwise it was destroyed.

During the latter part of the year a careful analysis was made of the value of the road stations. As a result of this study certain modifications were made in the road-station program. It was

definitely established that, for certain areas, the risk of spreading the worm by vehicular traffic was infinitesimal. No infested material had ever been intercepted at certain stations leading from areas where the infestation was light. A number of stations on roads leaving certain lightly infested areas were discontinued during May. All roads leaving areas where the infestation is general or heavy are, however, adequately guarded. Besides protecting uninfested areas these stations also serve to prevent the vehicular movement of infested products into lightly infested regions within the regulated area.

COOPERATION WITH MEXICO

All cotton produced in Mexico in areas adjacent to the regulated area in the United States is produced under regulations similar to those enforced in regulated areas in this country. The gins within these areas in Mexico are equipped with sterilizers and, with one exception, maintained, for the season of 1929, an average efficiency of 95 per cent or higher. These gins were also given a thorough cleaning at the end of the season. Under these conditions the lint is permitted to cross the border under bond for compression and fumigation, after which it is handled in the same manner as cotton from any regulated area within the United States. An excellent spirit of cooperation continues to be manifested by officials and citizens of Mexico in this regard.

COMPRESSION OF SECOND-CUT LINTERS BY ROLLERS

During the year a number of tests were made of a new method of compressing second-cut linters by means of rollers which could be used in connection with regular oil-mill operations. It was believed that roller compression would be of especial value for use with short linters, which when compressed by the old method were not as acceptable to the trade. These tests demonstrated that, when proper safeguards against contamination were employed, second-cut linters could, by means of rollers, be compressed in an economical manner which would make them more useful to the trade and at the same time give adequate protection against the spread of the pink bollworm. Following these tests the regulations were amended effective October 1, 1929, to authorize the use of the roller method of compression for second-cut linters.

DEVELOPMENT OF A MACHINE TO AID IN INSPECTION OF GIN TRASH

The value of inspection of gin trash for larvæ of the pink bollworm has been recognized for a number of years. Such inspections have, because of the large volume of trash which does not contain any worms, been very tedious and rather expensive. During the year an effort was made to develop a machine which would eliminate the greater part of the trash and still leave all the worms in a small residue. After a number of trials this effort was successful and led to the perfection of a machine which will, it is believed, materially increase the effectiveness of this method of inspection without additional cost.

REORGANIZATION OF WORK

In the latter part of the year the field administration of the work on pink bollworm and *Thurberia* weevil was reorganized. The area over which this work has to be carried on is very large and under the old plan it was not practicable to coordinate and adequately supervise all phases of the work. The reorganization provides for the establishment of three field districts—one including the eradication activities in the Salt River Valley of Arizona, another extending from the Santa Cruz River in Arizona to and including the El Paso and Mesilla Valleys, and the third including the eastern part of the area quarantined on account of the pink bollworm. The plan also provides for material changes in the method of directing the scouting to determine the possible presence and the abundance of the pink bollworm. This reorganization will make it possible effectively to supervise and coordinate the various activities and should not only assure more efficient work but permit savings in the employment and supervision of the personnel needed for these operations.

THURBERIA WEEVIL

The habits and general characteristics of the *Thurberia* weevil have been fully discussed in previous reports. The scouting to determine the spread of the weevil is, under cooperative arrangement, performed by the Bureau of Entomology, in connection with its research work on this insect. The quarantine and regulatory work is, however, all under the direction of the Plant Quarantine and Control Administration.

This insect has now become generally distributed in all of the cotton areas in the Santa Cruz Valley. The infestation extends from Marana, in the northern part of the valley, to Tubac, in Santa Cruz County, and was much heavier during the 1929 season than ever before. At Tubac, 5.7 man-days scouting resulted in the finding of 403 infested bolls and 413 weevil specimens, or an average of 70.7 infested bolls and 72.5 weevil specimens per man-day. At Sahuarita, 12 man-days scouting showed 543 infested bolls and 550 weevil specimens, or an average of 45.2 infested bolls and 45.8 weevil specimens per man-day, as compared to 14.4 infested bolls and 12.2 weevil specimens per man-day in 1928. Midvale showed 7.4 infested bolls and 4.4 weevil specimens per man-day, as compared to 7.2 infested bolls and 6.3 weevil specimens per man-day in 1928. These areas are all south of Tucson. The 1929 season's scouting showed the following results for the areas north of Tucson: Jaynes, 2.5 infested bolls and 4 weevils per man-day; Cortaro, 3.4 infested bolls and 3.4 weevils per man-day; Rillito, 2.4 infested bolls and 3.5 weevils per man-day; and Marana, 0.25 infested boll and 0.25 weevil per man-day. It will thus be seen that the infestation is much heavier in the southern part of the valley. In the Casa Grande area, 90.4 man-days scouting failed to reveal any weevil infestation.

The safeguards enforced to prevent the spread of the *Thurberia* weevil into nonregulated areas are the same as those used for the control of the pink bollworm. They consist of sterilization of seed, as a continuous process of ginning, compression and vacuum fumigation of lint, clean-up of gins, oil mills, etc., at the close of the season's operations, and road-station inspection. The results of the above

activities are included in those given for the pink bollworm, and will be found elsewhere in this report.

MEXICAN FRUIT WORM

The work for the fiscal year in the eradication of the Mexican fruit worm in the lower Rio Grande Valley of Texas included the completion on September 30, 1929, of the host-free period which began on March 1, 1929, the completion of the census of fruit trees for the year 1928-29, the inspection and certification of fruit during the shipping season, the clean-up of infested areas, the enforcement of the first half of the present host-free period, March 1 to June 30, 1930, and the completion of the census of fruit trees growing during the year 1929-30. Efforts have been continued throughout the year looking to the destruction of all alternate host-fruit trees.

ELIMINATION OF ALTERNATE HOST-FRUIT TREES

During the year 1,545 alternate host-fruit trees were destroyed. The great majority of these were trees that had come up during the past year from seed. This brings the total which were voluntarily destroyed by the citizens of the valley to 38,761, besides a number that were destroyed in the summer of 1927 of which no record was made. The cooperation of the citizens of the valley in taking these trees out has continued to be very good. However, in a number of cases during the past year the owners refused to take trees out. There are at present 187 such trees known to be in the quarantined area 145 of which are in Brownsville.

INSPECTIONS IN MEXICO

Inspections were made throughout the year at various points adjacent to the valley in Mexico. In March, in cooperation with the Mexican inspector at Matamoros, an inspection was made of all fruit growing in Mexico adjacent to the Texas border from the mouth of the Rio Grande to a point opposite Rio Grande City. At the same time a count was made of the fruit trees growing in this area.

INSPECTIONS IN ADJACENT TERRITORY

During June, 1930, an inspection was made of the fruit adjacent to the quarantined area and south and west of the Eagle Pass-San Antonio-Corpus Christi highways. The purpose of this inspection was to locate any incipient infestations that might have become established in the rather extensive plantings of peaches, plums, and citrus in this area. All inspections gave negative results.

INFESTATIONS

A heavy infestation of *Anastrepha ludens* was found in fruit growing in Matamoros, Mexico, in September, 1929. A hurried inspection revealed infestations on some 106 properties within the city; on a number of these premises the infestations approached 100 per cent in intensity. Several green fruits, which had not begun to turn color, were found infested.

In cooperation with Mexican officials clean-up measures were immediately instituted following the finding of the infestation. This consisted of stripping all stages of host fruits from the trees within the city limits of Matamoros, covering this fruit with quicklime and then with 3 feet of dry dirt. A total of 495 premises was cleaned of 1,208 field boxes of fruit. A thorough inspection of fruit growing along the border outside the city of Matamoros gave negative results.

Following the clean-up measures the trees in Matamoros were sprayed with a poison bait applied to the trees every four to seven days. Fly traps baited with fruit juice and also with orange extract were also placed in the patios which were most heavily infested. Numerous adult flies were caught in these traps.

Upon the determination of the infestation in Matamoros intensive inspections were made in Brownsville across the Rio Grande from Matamoros. Infestations were found in three back-yard plantings in the city of Brownsville on November 19, 1929, and immediately thereafter. An infested zone of approximately one-half mile extent in each direction from these points was at once established and trees cleaned of all host fruits. Further intensive inspections and the use of traps gave negative results.

As a precautionary measure the spraying of trees in Brownsville was started in October. This spraying was continued at 5-day intervals until March 22, when it was discontinued, as inspections subsequent to November had all given negative results.

HOST-FREE PERIOD

The host-free period began March 1. Due to the large amount of fruit in the grove at the time of the freeze considerable difficulty had been anticipated in getting the groves cleaned on time. However, the growers made a whole-hearted effort to get the fruit off and buried by the specified time. The tree-to-tree inspection by the inspectors to determine whether any fruit had been overlooked was carried out more rapidly by reason of the fact that the trees had been largely defoliated by the freeze, making any fruit left by the growers easily visible.

SPECIMENS COLLECTED

During the year, 2,913 specimens of *Anastrepha ludens* and 7,376 specimens of other insects were collected in the lower valley in Texas and Mexico and submitted for identification. Representatives of 19 families of the order Diptera were included in the latter.

Of the specimens of *A. ludens*, 69 larvæ were taken in Brownsville, Tex.; 1,983 larvæ (542 from home-grown and 1,441 from imported fruit) and 787 adults, caught in traps, were collected in Matamoros, Mexico; 29 larvæ in imported mangoes at Reynosa; and 45 larvæ in imported mangoes and mameys at Nuevo Laredo.

INSPECTIONS OF GROVES

Inspections of groves for infestations and maintenance of sanitary conditions were started early in September. Subsequently each commercial grove was inspected at monthly intervals or until it had been cleaned of all fruit. Certificates of inspection were withheld and fruit was not allowed to move from groves in which there was an excessive amount of dropped fruit or where the grove was too weedy.

Of 22,603 inspections made during the season, 2,053 certificates were temporarily withheld pending the proper cleaning of the premises.

INSPECTION OF PACKING PLANTS

Packing plants were inspected daily while in operation to ascertain whether they were kept in a sanitary condition. Records were checked to make sure that fruit was not being cut from unpermitted groves. Fruit in the process of being packed was inspected for signs of infestation. Canning plants and juice plants were inspected regularly to see that débris was properly disposed of.

PERMITS ISSUED

An effort was made to limit the issuance of season permits to those firms doing a commercial packing business. Growers and individuals shipping only a few hundred boxes were prevailed on to use the single-box permit system under the inspectors' permits. General permits were issued to 160 firms and individuals.

SHIPMENTS OF FRUIT

The quantity of fruit shipped from the quarantined area was more than double that of the season of 1928-29 despite the fact that a severe freeze occurred in January with approximately 20 per cent of the fruit still on the trees. During the season 3,979 carloads of fruit were moved by rail, 82,775 eighty-pound boxes, or approximately 238 carloads, were shipped by express, while 254,878 boxes and baskets, or approximately 637 carloads, were carried out of the area in trucks and passenger autos. Thus approximately 4,854 carloads of fruit were moved from the quarantined area during the season of 1929-30. In addition to the shipments of fresh fruit the canning and bottling plants utilized approximately 20,000 boxes, or 57 carloads. A conservative estimate places the amount of fruit destroyed by the freeze of January and subsequently buried at 1,000 carloads.

DATE-SCALE ERADICATION

During the fiscal year 1930, increased Federal funds and appropriations by the States of Arizona and California made it possible to carry on the enlarged program of work suggested by the survey of the project made in the last half of the fiscal year 1928 and in 1929. The inspection force was tripled and intensive inspection was carried on over the entire date-growing areas of Arizona and California, interrupted only by the more frequent inspections and treatment necessary in infested gardens.

COACHELLA VALLEY

Approximately 140,000 date palms were located in the Coachella Valley during the survey of that area. A large number of these were in abandoned seedling gardens so bushy, full of dead leaves, and overgrown with desert brush that close inspection was impossible, and many of these plantings were infested. During the past year 24,320 of these palms were dug out and destroyed.

Of the remaining palms most were in commercial gardens and were inspected by crews of routine inspectors. Several thousand palms

were small and easily inspected and many were in small dooryard or ornamental plantings. The latter were inspected by scout inspectors working singly or in pairs. A constant outlook was kept for plantings, especially on abandoned properties, which had not been located previously.

During the fiscal year 1929, 430 infested palms were found on 27 properties. In the fiscal year 1930, intensive inspection and clean-up work was continued on these same properties and 59 infested palms found. Of these, 47 were found in the first six months of the fiscal year 1930 and 12 in the last six months.

Of the 27 properties showing scale in the fiscal year 1929, only 12 showed scale in the present fiscal year and 7 of the 12 in the last six months.

In addition to the inspection in the infested gardens, all the plantings in the Coachella Valley were carefully inspected and the plantings in the infested area reinspected. Many of these plantings had previously received only hurried scout inspections. Fifteen newly infested properties were found during this intensive inspection, all being located in that portion of the valley designated as the infested area by the first survey. Eight of these newly infested properties were holdings in one subdivision, one infestation being severe enough to be considered a center of spread. Of the remaining 7 new infestations, 2 were commercial plantings and 5 were seedling plantings of no commercial value. A total of 435 infested palms was found on these 15 newly infested properties, 325 during the first six months of the fiscal year and 110 during the last six months.

IMPERIAL VALLEY

In the Imperial Valley approximately 35,000 date palms were located and infestations were found only in the southern part of the county. Most of the palms in this district, about 10,000 in all, are in small dooryard or ornamental plantings. Only two plantings, and these infested, totaling 973 palms, are extensive enough to require inspection by routine crews.

Work in the valley during the fiscal year 1930 was confined to this district. The large plantings were inspected by routine crews from the Coachella Valley and the remainder by scout inspectors stationed at El Centro. Careful inspections of the district were made at intervals of about four months, efforts being made to locate palms overlooked in the first survey.

During the year, 30,495 palm inspections were made and 92 infested palms found on 30 properties, 11 of these new infestations, as contrasted with 1,115 infested palms found on 60 properties in the fiscal year 1929.

PHOENIX DISTRICT

Over 42,000 date palms are planted in the Phoenix or Salt River Valley district. About 6,000 of these require routine inspection and were inspected by routine crews from the Coachella Valley. The remainder, small ornamental plantings or young commercial plantings, were inspected by scout inspectors from Phoenix. During the year, 59,602 palm inspections were made and 27 infested palms found on 5 properties, 1 being a new infestation, as contrasted with 45 infested

palms found on 12 properties in 1929. All of the infestations were in ornamental plantings in or near the city of Phoenix.

YUMA DISTRICT

Approximately 20,000 date palms were located in the Yuma district. About 3,000 of these were inspected by routine crews from the Coachella Valley and the remainder, small plantings, were inspected by scout inspectors with headquarters at Phoenix. During the year, 25,652 palm inspections were made and eight infested palms found on three properties. The infested palms were ornamentals in the city of Yuma.

PRESENT STATUS

In the Coachella Valley, owing to the limited area under irrigation, it is quite probable that all date palms have been located and are being inspected at regular intervals. It is possible, however, that a few palms on abandoned properties overgrown with desert brush have been overlooked.

No infestations severe enough to be classed "centers of spread" have been found since August, 1929, when the first intensive inspection of the valley was completed. The number of infested palms found on the old infested properties showed a reduction with each inspection during the year and the infestations on the individual palms were less severe.

In the Salt River Valley the number of palms will not exceed 45,000, but they are distributed over a large area and 7,134 of them are in small plantings in the city of Phoenix. It is known that *Parlatoria* scale has occurred in the Salt River Valley for many years, but the spread has been limited to a great extent to the movement of offshoots from infested plantings. Most of the commercial plantings are comparatively young and many of the palms were obtained in the Coachella Valley.

The commercial plantings were kept under observation during the year but no scale was found. Systematic inspection was also carried on over the entire area for scale and in the effort to locate palms overlooked in previous surveys. Only one new infestation was found during the year and only four of the old infestations showed scale during the year.

In the Yuma district there are a few commercial gardens, but most of the date palms are in ornamental or dooryard plantings. Many of the palms in the commercial gardens were obtained from the Coachella Valley.

The only infested palms found in this area were ornamentals which were probably infested when the city of Yuma was generally infested several years ago; the infestation had resulted from scale on the leaf bases that had been overlooked when the trees were treated previously.

The condition in the Imperial Valley is very similar to that in the Salt River Valley although scale is much more prevalent. During the year repeated inspections and treatment of infested palms have greatly reduced the number of infested properties and intensity of infestation.

QUARANTINE ON DOMESTIC NARCISSUS

The finding of more or less severe bulb-eelworm infestations in Alabama, Georgia, and Oregon and the discovery that this pest is more prevalent in the States of Michigan and Washington than had previously been known, constitute the most important developments of the year in connection with the enforcement of the quarantine regulating the interstate movement of narcissus bulbs. At the same time, the infestations formerly listed from Kansas, North Carolina, and Rhode Island were not reported in 1929 by the nursery inspectors of those States as persisting in the plantings in which the eelworms had previously been found. The discoveries in Alabama, Georgia, and Oregon were made during the winter and spring in connection with the inspection of the 1930 bulb crop.

Both the field and harvest inspections of narcissus bulbs are made by the inspection services of the various States cooperating with the Plant Quarantine and Control Administration. The number of narcissus bulbs in this country listed by such inspectors continues to increase. The total so reported for the calendar year 1929 numbered 273,507,749, of which 174,333,504 were Paper White and other polyanthus types commonly grown in the South, and 99,174,245 were the hardy daffodil types common in the Northern States. These figures indicate approximately a 25 per cent increase over the previous year. A total of 218,400,284 bulbs was reported as having been certified for interstate movement, of which 76 per cent were certified as uninfested, and the remaining 24 per cent were treated. The details for the different States are being published in the Service and Regulatory Announcements of the administration. (See S. R. A. No. 103.)

Lesser bulb flies were definitely reported for specific plantings in Illinois, Maryland, Michigan, Minnesota, New Jersey, New York, North Carolina, Pennsylvania, Virginia, and Washington. They are also known to be established in California, Ohio, and Oregon, and have recently been discovered in Alabama. The greater narcissus fly was definitely reported in New York, North Carolina, Oregon, and Washington. For the bulb crop of 1929, *Tylenchus dipsaci* infestations were reported definitely only in Michigan, New York, and Virginia. In addition they are known to occur in various bulb plantings in California and Washington and, as reported above, were found in the spring field inspection of 1930 in Alabama, Georgia, and Oregon. One infestation of *Aphelenchus subtenuis* was reported from Texas in the 1929 crop.

Transit inspectors and other employees and collaborators of the administration reported 419 shipments intercepted as violations of the narcissus-bulb quarantine during the fiscal year. This is a considerably larger number than were reported during the previous year, but the increase is believed to be apparent rather than real and to be due to the fact that in the fall of 1928 the temporary inspectors engaged in transit inspection were not assigned to that work until after a considerable part of the bulb-shipping season had passed.

WHITE-PINE BLISTER-RUST QUARANTINE ENFORCEMENT

The Federal quarantine relating to the white-pine blister-rust disease has three primary purposes: (1) Preventing the interstate movement of possibly infected pine trees and currant and gooseberry

plants into 5-leaved pine-growing areas which the blister rust has not yet reached, such as those of the southern Appalachian Range of the East and the Sierra Nevada Mountains of the West; (2) assisting the States which have established blister rust control areas in preventing the introduction of currant and gooseberry plants into such areas, and (3) inspecting the premises and environs of pine-growing nurseries in the generally infected States when the owners desire to propagate 5-leaved pines under such sanitary conditions that they can be safely authorized to ship such pines to lightly infected States.

The safeguards established by the blister-rust quarantine regulations to accomplish these purposes restrict the movement of 5-leaved pines and currant and gooseberry plants by limiting the destinations to which these plants may be sent from the infected and neighboring States, and by requiring, in the case of currant and gooseberry plants, such conditions of dormancy, defoliation, and chemical treatment that nursery-stock shipments could not transmit blister-rust infection. These safeguards are such that it is in most cases unnecessary for department employees to inspect and certify nursery-stock shipments of this kind prior to shipment, as it is possible to determine compliance by examining the stock en route, with a much smaller personnel and at greatly reduced cost. This plan of enforcing the blister-rust quarantine regulations by means of inspection in transit at strategic express, parcel-post, and freight-distribution centers has accordingly been followed for some years past. Since a coordinated system of transit inspection for aiding in the enforcement of the various quarantines is being organized, this subject is discussed separately on a later page.

As will be noted from Table 15, 113 violations of the blister-rust quarantine have been intercepted during the year by transit inspectors, the stock in all cases being returned to the consignor. Of these violations 48 were shipped by commercial nurserymen and the remaining 65 by persons not commercially interested in the transportation of nursery stock. Five additional violations of this quarantine were discovered by those engaged in enforcing the reshipment restrictions of the Mediterranean fruit fly quarantine regulations, and 59 were intercepted at road stations established to enforce the Japanese-beetle quarantine.

The only field inspections which are made by the administration in connection with this quarantine consist of going over the premises and environs of pine-producing nurseries in the generally infected States where such nurseries are attempting to comply with the sanitation requirements necessary to enable them to ship into the more lightly infected regions. Such movement is authorized when the pines concerned have been raised from seed in a nursery free from currant and gooseberry plants and with a *Ribes*-free zone around the premises. Only 3 nurseries have been issued such permits thus far; 1 in Maine, 1 in Vermont, and 1 in New York. In addition, a tract in Connecticut on which a nurseryman wishes to plant 5-leaved pines was tentatively approved. A number of additional inspections were made in June, 1930, and it is probable that other nurseries will be able to comply with the requirements in the future.

PHONY PEACH DISEASE

The discovery of a number of phony peach disease infections in four States outside the previously quarantined area during the last few weeks of the fiscal year has constituted a most important development in the campaign to prevent the spread of that disease.

In July, 1929, the infection was believed to be confined to the fruit-producing area of Georgia, except for an extension west into Lee County, Ala. The territory known to be involved consisted of 64 counties of central and western Georgia and 1 county of eastern Alabama. As a result of surveys conducted during that summer, 19 counties in Georgia and 6 counties in Alabama were added to the regulated areas on November 1.

Late in the fall several infected trees were found in each of three Mississippi counties, and on April 24, 1930, a hearing was held at Washington to consider extending the quarantine to that State. In May and June, before action had been taken as a result of the hearing, the disease was discovered in new localities in nine more counties of Mississippi, near Monticello and Warren, Ark., Monroe and Bastrop, La., and Winchester and Cleveland, Tenn.

At all these recently discovered points of infection, the number of diseased trees thus far found is very limited. These infections have apparently come about, judging from the evidence now at hand, by the shipment of nursery stock during the past 10 years from the generally infected area of Georgia, and the disease has not yet had time to spread widely in the newly infected areas. The extent to which the new discoveries will necessitate modification of the quarantine and eradication policies has not yet been determined.

It will be recalled that the phony peach disease is an infectious condition of the root system which has the effect of dwarfing peach and nectarine trees and eventually making them valueless by reducing the size and quality of the crop. The trees are not killed, but the peach crop becomes so greatly reduced that the orchard is unprofitable.

An eradication campaign is being undertaken by the Bureau of Plant Industry in cooperation with the States concerned, and considerable progress in the extermination of the disease is reported in northern Georgia and northeastern Alabama. The responsibility of the Plant Quarantine and Control Administration with respect to the disease has been limited to that of preventing further interstate spread by the shipment of infected nursery stock. Under the Federal quarantine regulations as revised effective November 1, 1929, the regulated areas are divided into generally infected and lightly infected districts, respectively. Within the former the disease has been established for some years and little progress toward complete eradication has as yet been made. The commercial orchards of the lightly infected areas have, however, been covered in tree-to-tree surveys, and the infected trees have been or are being destroyed.

The quarantine regulations limit the interstate movement of peach and nectarine nursery stock from the regulated areas to outside points, to trees which have been produced in nurseries "within which and within 1 mile of which no infection of the phony peach disease has existed for at least two years prior to the proposed date of movement." Similar restrictions are placed on such shipments from the generally infected to the lightly infected areas, and State quarantines govern intrastate movement in the same manner.

Eight Georgia nurseries and one Alabama nursery were issued permits under these requirements in the fall and allowed to ship interstate to points outside the regulated area during the fall, winter, and spring nursery-stock shipping seasons. Similar permits were issued to 11 dealers who handle healthy stock not grown by themselves. Permits were refused to nine Georgia nurseries and two Alabama nurseries because of the discovery of infection within the prescribed limits.

In view of the importance of Concord, Ga., as a peach nursery-stock shipping point and particularly on account of the fact that part of the plantings of certain large nurseries appeared to be eligible for movement while other plantings were not, it became necessary to station an inspector at that point throughout the shipping season. The duties of this inspector were primarily to certify shipments of approved stock offered for movement to points outside the generally infected area. Two thousand and fifty-nine shipments were certified for the principal nurserymen located at Concord. These shipments were destined to points throughout all the Southern States and in other parts of the United States, as far north as New York and as far west as Oklahoma.

The quarantine regulations were enforced primarily by the inspection of interstate shipments of nursery stock in transit at such important distribution points as Atlanta, Ga., Birmingham, Ala., and Memphis and Nashville, Tenn. Six shipments found to be moving in violation of the requirements were intercepted and turned back to the shippers. The details of the number of shipments inspected and the number intercepted are shown in Tables 15 and 16.

TRANSIT INSPECTION

As has been reported on a previous page, a considerable part of the appropriation for the prevention of spread of the white-pine blister rust has been devoted for several years to the inspection of nursery stock in transit at important freight, express, and mail distribution centers. During the past season this plan was also adopted as an important part of the phony peach disease quarantine enforcement program, and the work also proved of value in administering Federal quarantines on account of such important plant pests as the Mediterranean fruit fly, the European corn borer, the Japanese beetle, and others.

Work of this type under the several quarantines is being unified and coordinated, and during the coming fiscal year will be carried on under an appropriation for the specific purpose of engaging in transit inspection activities. As will be seen from the considerable number of violations of the various quarantines as reported in Table 15, this work is proving of very material value in preventing the spread of these pests. The number of shipments of nursery stock and other plants inspected in transit at the various inspection points is shown in Table 16. These tables do not include the transit inspection activities carried on by the Mediterranean fruit fly eradication organization at Jacksonville, Fla., nor those by the Japanese beetle control staff at New York and Philadelphia, which have already been discussed.

TABLE 15.—*Summary of shipments of nursery stock and other articles intercepted in violation of Federal plant quarantines at transit inspection points, fiscal year 1930*

Station	Q. 38		Q. 43		Q. 45		Q. 48		Q. 53		Q. 62	
	C	NC	C	NC	C	NC	C	NC	C	NC	C	NC
Atlanta.....							0	1			2	0
Baltimore.....							2	0				
Birmingham.....											5	2
Chicago.....	0	1	16	96	3	16	17	31			94	28
Cincinnati.....			0	1								
Cleveland.....											3	0
Council Bluffs.....					0	1	0	1			0	1
Indianapolis.....			0	1								
Kansas City.....					0	1	1	0			18	1
Nashville.....							1	0			2	2
New York.....					13	32	43	69	0	4	172	9
Ogden.....											0	2
Omaha.....							1	0			5	1
Portland.....									0	2	9	15
St. Paul.....					0	1	0	2				
Seattle.....	1	0							0	2	3	3
Spokane.....	0	1									9	5
Total.....	1	2	16	98	16	51	65	104	0	8	322	69

TABLE 15.—*Summary of shipments of nursery stock and other articles intercepted in violation of Federal plant quarantines at transit inspection points, fiscal year 1930—Continued*

Station	Q. 63		Q. 64		Q. 48 and Q. 66		Q. 67		Q. 68		Total	
	C	NC	C	NC	C	NC	C	NC	C	NC	C	NC
Atlanta.....					1	2	5	0	30	5	38	8
Baltimore.....									10	2	12	2
Birmingham.....	0	1	0	1			1	0	11	4	17	8
Chicago.....	23	25			3	12			3	8	159	217
Cincinnati.....	1	0							1	0	2	1
Cleveland.....											3	0
Council Bluffs.....	1	2									1	5
Indianapolis.....											0	1
Kansas City.....	2	5			1	2			17	0	39	9
Minneapolis.....	0	2									0	2
Montgomery.....			0	1							0	1
Nashville.....	0	1	1	1					22	12	26	16
New York.....	7	5			35	40			3	1	273	160
Ogden.....											0	2
Omaha.....	1	6			0	1					7	8
Pocatello.....	1	0									1	0
Portland.....	8	3									17	20
St. Louis.....			0	1							0	1
St. Paul.....	2	9									2	12
Seattle.....	1	5									5	10
Spokane.....	1	1									10	7
Washington, D. C.....									12	0	12	0
Total.....	48	65	1	4	40	57	6	0	109	32	624	490
Grand total.....											1,114	

EXPLANATION OF TABLE.—The figures given above represent the number of shipments intercepted at the transit inspection points indicated, in violation of the quarantine whose number appears at the top of the column. Q. 38 relates to black-stem rust; Q. 43, to the European corn borer; Q. 45, to the gipsy moth and brown-tail moth; Q. 48, to the Japanese beetle; Q. 53, to the satin moth; Q. 62, to narcissus pests; Q. 63, to the white-pine blister rust; Q. 64, to the Mexican fruit worm; Q. 66, to the Asiatic beetle and the Asiatic garden beetle; Q. 67, to the phony disease of peach, and Q. 68 to the Mediterranean fruit fly. C indicates packages sent by commercial shippers; NC, shipments by those not commercially engaged in the business to which the quarantine relates. The totals do not include interceptions at road stations, reports by collaborators, or information received from sources other than inspection of rail shipments in transit.

TABLE 16.—Shipments of nursery stock and other plants and plant products inspected in transit, fiscal year 1930

Station	Period	Shipment by—			Total
		Parcel post	Express	Freight	
Atlanta.....	{ Fall.....	1, 544	4, 315	52	5, 911
	{ Spring.....	2, 552	13, 723	410	16, 685
Baltimore.....	{ Spring.....	0	2, 520	479	2, 999
	{ Fall.....	1, 314	2, 545	33	3, 892
Birmingham.....	{ Spring.....	2, 945	7, 890	125	10, 960
	{ Fall.....	35, 516	11, 755	127	47, 398
Chicago.....	{ Spring.....	169, 904	35, 233	1, 085	206, 222
	{ Fall.....	0	179	0	179
Cincinnati.....	{ Spring.....	11, 077	4, 538	100	15, 715
	{ Fall.....	1, 780	77	0	1, 857
Cleveland ¹	{ Spring.....	0	567	0	567
Columbus ¹	{ Fall.....	269	20	0	289
Indianapolis ¹	{ Spring.....	8, 896	9, 992	360	19, 248
	{ Fall.....	33, 057	9, 966	167	43, 190
Kansas City.....	{ Spring.....	7	3, 801	0	3, 808
	{ Fall.....	1, 115	1, 912	86	3, 113
Louisville.....	{ Spring.....	501	1, 462	39	2, 002
	{ Fall.....	1, 774	3, 980	430	6, 184
Memphis.....	{ Spring.....	13, 941	15, 353	655	29, 949
	{ Fall.....	3, 222	6	0	3, 228
Nashville.....	{ Spring.....	171, 713	1, 909	0	173, 622
New Haven ¹	{ Fall.....	204, 629	6, 029	0	210, 658
New York.....	{ Spring.....	4, 113	1, 349	173	5, 635
	{ Fall.....	3, 171	394	0	3, 565
Ogden.....	{ Spring.....	23, 571	9, 478	1, 526	² 34, 575
	{ Fall.....	705	592	9	1, 306
Omaha and Council Bluffs.....	{ Spring.....	0	4, 742	3, 631	8, 373
Pendleton.....	{ Fall.....	1, 161	1, 253	133	2, 547
Pittsburgh.....	{ Spring.....	5, 265	4, 877	2, 056	12, 198
	{ Fall.....	24, 539	6, 372	571	31, 482
Pocatello.....	{ Spring.....	0	55	0	55
	{ Fall.....	532	14, 206	24	14, 762
Portland.....	{ Spring.....	901	321	0	1, 222
	{ Fall.....	28, 717	11, 002	225	39, 944
St. Louis.....	{ Spring.....	4, 447	535	17	4, 999
	{ Fall.....	7, 600	1, 215	76	8, 891
St. Paul and Minneapolis.....	{ Spring.....	2, 914	451	390	3, 755
	{ Fall.....	19, 071	2, 748	358	22, 177
Seattle.....	{ Spring.....	0	250	0	250
Spokane.....	{ Fall.....	792, 463	197, 612	13, 337	² 1, 003, 412
Washington, D. C.....					
Total.....					

¹ Few days only.
² Plus 1 carload.

BLACK STEM RUST QUARANTINE

The Federal quarantine restricting the interstate movement of certain species of Berberis and Mahonia plants has been issued to aid 13 grain-growing States, mainly in the Mississippi Valley, in accomplishing the total eradication of these plants throughout that area. The campaign is directed toward the prevention of black stem rust epidemics in those States. Three violations of this quarantine were intercepted by transit inspectors of the administration during the fiscal year.

According to the Bureau of Plant Industry, the States concerned, in cooperation with that Bureau, destroyed 551,685 barberry bushes, seedlings, and sprouts during the calendar year 1929, making a grand total of 18,143,999 such bushes, seedlings, and sprouts destroyed since the campaign began in the spring of 1918.

WOODGATE-RUST QUARANTINE

Since November, 1928, a quarantine has been in effect prohibiting the interstate movement of Scotch pines and certain other hard pines from the northeastern part of New York State to other sections of

the country. This order was issued for the purpose of preventing the spread of the Woodgate rust, a disease which was apparently introduced into that area some 25 to 30 years ago and which has not yet spread to other sections of the United States. The disease attacks Scotch pine with especial virulence, causing galls or swellings on the trunks and limbs of the trees and destroying the value of the pine for lumber. It is difficult to control because of the fact that it spreads directly from pine to pine without the intervention of an alternate host. Ten New York counties are now included within the regulated area, namely, Clinton, Essex, Franklin, Hamilton, Herkimer, Jefferson, Lewis, Madison, Oneida, and St. Lawrence.

No violations of this quarantine were intercepted during the fiscal year.

FOREIGN PLANT QUARANTINES

The enforcement of the various foreign-plant quarantines and regulatory orders of the department is performed by inspectors or collaborators of the Plant Quarantine and Control Administration stationed at the more important ports of entry and foreign mail-distributing points where the work is conducted in close cooperation with the Treasury, Labor, Post Office, and State Departments. Since descriptive matter relating to the various foreign quarantines and regulatory orders enforced by the administration is available elsewhere, these quarantines are not discussed in this report except in the summary of new quarantines and amendments of old quarantines given on pages 82 to 85. A record of the inspection work performed at the various ports of entry and elsewhere in the United States in the enforcement of foreign quarantines follows.

PLANT-QUARANTINE INSPECTION

The enforcement of foreign plant quarantines and regulatory orders at maritime, interior, and Mexican border ports of entry involves: (1) The inspection of vessels and aircraft arriving at ports of entry from foreign ports and from Porto Rico and Hawaii; (2) the inspection and disposition of restricted plants and plant products found by customs or immigration officials or by inspectors of the administration in the baggage of persons entering the United States from foreign countries or from Porto Rico or Hawaii; (3) the inspection of plants and plant products, including nursery stock, seeds, bulbs, fruits, and vegetables entered under permit from foreign countries and localities, and certain products arriving from domestic territory; (4) supervision of the disinfection (fumigation or sterilization) of cotton, cotton bagging, broomcorn, and other products requiring such treatment as a condition of entry; (5) inspection, in cooperation with customs and post-office officials, of restricted plants and plant products arriving by foreign parcel post; (6) inspection of plants and plant products introduced by the Department of Agriculture and all plants imported under special permit in accordance with the provisions of regulation 14, quarantine No. 37; (7) field inspection of plants imported under special permit and grown under agreement; (8) inspection of plants (domestic) entering and leaving the District of Columbia; (9) inspection of plant-introduction gardens of the Bureau of Plant Industry; and (10) inspection of fruits and vegetables in the field and at the point of shipment in Porto Rico

and Hawaii in accordance with the provisions of quarantines Nos. 58 and 13, respectively. In addition, this service inspects and certifies export fruits and vegetables to meet the sanitary requirements of certain foreign countries, and at certain ports assists flour exporters by inspecting the holds of vessels and warehouses for the presence of stored-grain insects.

The continued development and expansion of foreign air-transportation lines has greatly increased the problem of providing safeguards against the introduction of foreign plant pests, as is evidenced by the fact that inspectors and collaborators of the administration inspected more than twice as many airplanes from foreign countries this fiscal year as were inspected the preceding fiscal year. Four thousand four hundred and ninety-seven airplanes were inspected during the fiscal year 1930 and 400 interceptions of contraband plant material were made. Among the destructive plant pests found in this contraband plant material was the pink bollworm of cotton, *Pectinophora gossypiella*. These inspections were made at landing fields located at Brownsville, Eagle Pass, El Paso, and Laredo, Tex.; Miami, Fla.; San Diego, Calif.; and San Juan, Porto Rico. By a cooperative arrangement with airplane companies and officials of the Mexican Government 76 airplanes were also inspected for contraband plant material at Agua Caliente, Mexico, prior to the planes' crossing the border.

In addition to the inspection of airplanes from foreign countries, inspectors and collaborators of the administration inspected the dirigible *Graf Zeppelin* at Lakehurst, N. J., on August 4, 1929; at Los Angeles, Calif., on August 26, 1929, and at Lakehurst again on May 31, 1930. Plant material intercepted on the *Graf Zeppelin* upon its arrival from Germany August 4, 1929, harbored 20 species of insects, 6 of which were not known to occur in the United States. Oranges from Brazil and potatoes from Germany, both of which are prohibited entry into the United States, were intercepted when the *Graf Zeppelin* arrived at Lakehurst, N. J., on May 31.

MEXICAN-BORDER SERVICE

Increased appropriations available during the course of the fiscal year made it possible to place inspectors at nine new ports of entry as follows: Naco, Ariz., Columbus, N. Mex., and Ysleta, Fabens, Presidio, Mercedes, Roma, Rio Grande City, and Zapata, Tex. In addition, the personnel at eight other ports was materially strengthened. Plant-quarantine inspectors are now stationed at 19 ports on the Mexican border.

At the seven ports having rail connections with Mexico a total of 47,997 freight cars was inspected in the Mexican railway yards. Of these 45,657 entered the United States and 18,565 were fumigated as a condition of entry. Three thousand nine hundred and twenty-five cars were found to be contaminated with cottonseed and were required to be cleaned before entry was permitted. A charge of \$4 was made for each car fumigated and all fees collected were covered into the Treasury as miscellaneous receipts.

A summary of the railway-car inspection and fumigation is given in Table 17.

TABLE 17.—*Inspection and fumigation of railway cars crossing the border from Mexico, fiscal year 1930*

Port	Cars inspected	Cars with cottonseed	Cars entered	Cars fumigated	Fees collected
Brownsville.....	699	84	696	375	\$1,500
Douglas ¹	1,346	40	1,346	73	292
Eagle Pass.....	4,337	1,179	3,660	3,044	12,492
El Paso.....	14,090	510	13,681	2,495	9,980
Laredo.....	11,934	1,788	11,029	9,082	36,000
Naco.....	1,653	40	1,653	83	332
Nogales.....	13,938	284	13,592	3,413	13,200
Total.....	47,997	3,925	45,657	18,565	² 73,796

¹ Does not include 1,622 gondolas which crossed to the smelter, unloaded, and returned to Mexico.

² The apparent discrepancy in fees collected and the number of cars fumigated may be explained by the fact that it is customary for the railroads to purchase fumigation coupons in advance.

In addition to the freight cars listed in Table 17, 4,308 Pullman and passenger coaches crossing the border were inspected. Inspectors of the administration cooperate with the customs service in the inspection of baggage, personal effects, and express packages from Mexico, and with the customs service and Post Office Department in the inspection of foreign parcel-post packages. During the fiscal year under consideration 71,637 pieces of baggage and 1,083 parcel-post packages were examined. As a result of these inspections a large number of prohibited plants and plant products have been intercepted, many of which were found to be infested with injurious plant pests. A list of the more important interceptions of prohibited plants and plant products is included in Table 18.

TABLE 18.—*Contraband plants and plant products intercepted at Mexican border ports, fiscal year 1930*

Commodity	Brownsville		Calexico		Columbus ¹		Del Rio		Douglas		Eagle Pass		El Paso		Fabens ²		Hidalgo		Laredo	
	Inter-ceptions	Quantity ¹⁰	Inter-ceptions	Quantity ¹⁰	Inter-ceptions	Quantity ¹⁰	Inter-ceptions	Quantity ¹⁰	Inter-ceptions	Quantity ¹⁰	Inter-ceptions	Quantity ¹⁰	Inter-ceptions	Quantity ¹⁰	Inter-ceptions	Quantity ¹⁰	Inter-ceptions	Quantity ¹⁰	Inter-ceptions	Quantity ¹⁰
Apples	192	590	18	106			22	38	182	508	178	574	1,236	5,066	8	13	156	521	567	1,955
Apricots			1	1	1	8			22	229	7	142	32	448			7	107	26	745
Avocados	150	1,106	6	19			52	133	1	1	192	956	441	1,196			90	484	419	2,187
Avocado seed	23	94	1	1			4	9	3	4	26	109	93	200	1	3	50	195	105	336
Cherimoyas	5	14									8	9	24	45			9	16	27	45
Cherries									22	984	1	27	8	328			1	108	10	306
Corn (ears)	49	539	36	352			26	228	29	142			170	700	2	3				
Corn (pounds)	8	1					2	2			40	166	106	187	39	6	47	181	111	460
Cotton bolls	48	217			3	116							116	623			45	191	4	31
Cotton lint (pounds)	15	75							4	5	2	6	104	56	16	57	26	49	27	58
Cottonseed (pounds)	22	2							2	7			57	17	48	5	7	10	13	26
Seed cotton (pounds)	7	42											65	38	7	1				
Dates	12	548	22	75							1	200	1	11			4	152	1	9
Figs	19	401	4	45			23	1,365	1	50	103	5,845	124	3,302			19	291	129	3,606
Grapefruit	178	840	108	956					10	225	4	9	56	319			261	837	47	155
Guavas	17	74					2	10	3	7	24	290	73	286			7	58	147	874
Kumquats	9	26	1	15									1	2			1	1		
Maneys	58	110					7	9			15	25	29	44			54	97	146	270
Mangoes	40	94					30	57	6	8	40	149	282	652	1	3	20	54	196	531
Oranges	374	1,488	267	2,732	2	4	105	316	239	776	311	817	1,151	3,851	12	23	485	1,631	1,026	3,419
Papayas	8	12															3	10	6	10
Peaches	32	214	1	6			18	239	43	369	51	615	277	1,766			38	287	173	1,562
Pears	40	194	3	3			4	8	41	159	38	111	384	1,726			20	42	154	622
Plants	212	1,833	69	394	8	64	38	262	89	871	79	629	774	6,594	10	57	124	4,946	334	4,699
Plums	4	62	1	3	2	50	3	64	20	174	7	71	97	1,700			15	242	42	881
Pomegranates	28	96	5	5			12	98	14	53	47	332	78	225			29	104	115	455
Potatoes	61	557			3	58					41	185	199	2,223	3	6	52	858	83	1,285
Quinces	26	65					14	43	25	39	44	188	142	350			23	96	173	518
Sapotes							3	5			1	1	226	356			3	23	22	99
Sugarcane			75	186			60	134	14	23	48	226	385	482			18	89	117	700
Sweet limes	8	35	1	12					19	35	7	59	67	250			13	88		
Sweetpotatoes	18	145	8	140			8	44	12	61	35	175	66	677			11	50	47	475
Tangerines			24	185							3	52	7	25			84	390	34	249

Commodity	Mercedes ³		Naco ⁴		Nogales		Presidio ⁵		Rio Grande City ⁶		Roma ⁷		San Ysidro		Ysleta ⁸		Zapata ⁹		Total	
	Inter-ceptions	Quantity ¹⁰	Inter-ceptions	Quantity ¹⁰	Inter-ceptions	Quantity ¹⁰	Inter-ceptions	Quantity ¹⁰	Inter-ceptions	Quantity ¹⁰	Inter-ceptions	Quantity ¹⁰	Inter-ceptions	Quantity ¹⁰	Inter-ceptions	Quantity ¹⁰	Inter-ceptions	Quantity ¹⁰	Inter-ceptions	Quantity ¹⁰
Apples	50	134	149	385	349	1,303	6	16	1	2	47	154	661	3,850	11	39	4	12	3,837	15,266
Apricots					66	2,801							75	1,145					237	5,626
Avocados	7	27			35	101	2	6	6	36	9	59	27	47	1	6			1,438	6,364
Avocado seed	13	53	9	29	8	15			1	3			2	9	1	1			340	1,061
Cherimoyas					2	15							2	2					77	146
Cherries			1	28	10	309									2	175			55	2,265
Corn (ears)	56	716	10	65					2	21	102	723	23	278	5	5			510	3,772
Corn (pounds)	21	152	33	91	168	852	2	51					18	111			9	45	589	2,310
Cotton bolls	16	100	2	2	2	2									2	2			252	1,281
Cotton lint (pounds)	25	60	7	13	25	29									4	8			255	1,416
Cottonseed (pounds)	34	82	2	8	5	7	13	1	1	1	30	34			26	14	8	3	268	217
Seed cotton (pounds)															12	1			91	82
Dates	1	18			115	5,836							2	62					159	6,911
Figs	1	34	1	36					1	7	1	20	47	705			2	20	532	16,463
Grapefruit	134	838	3	68	53	313					3	4	119	502					976	5,066
Guavas	1	5	1	1	16	133							5	187					296	1,925
Kumquats	2	14																	14	58
Mameys	1	1	1		11	68													321	624
Mangoes	2	6	5	6	153	733			1	4			1	1					779	2,307
Oranges	196	680	218	501	657	2,231	13	18	3	4	17	43	1,374	14,635	10	23	3	8	6,463	33,200
Papayas					18	40													35	72
Peaches	4	7	32	117	150	1,711					1	7	207	1,497					1,027	8,397
Pears	5	26	21	72	109	246					1	4	167	874	1	1			988	4,088
Plants	78	663	69	447	166	2,920	5	134	6	7	105	754	174	1,549	7	47	10	36	2,357	26,906
Plums	1	8	4	36	72	1,165	2	12					136	1,771					406	6,239
Pomegranates	3	6	19	42	62	142					3	13	20	67					435	1,638
Potatoes	42	305	16	70							5	19	50	777	11	93	5	80	576	6,542
Quinces	1	1	32	56	129	677	4	21					1	1					610	2,034
Sapotes					4	14													259	498
Sugarane	9	196	17	19	102	309			10	35	10	83	24	80	2	2	3	37	894	2,601
Sweet limes			16	74	97	471							2	44					230	1,068
Sweetpotatoes	8	92			93	501					2	9	12	63	1	8	1	6	322	2,446
Tangerines	47	196	1	6	3	32							32	225					235	1,360

¹ Inspector stationed at Columbus Apr. 23, 1930.² Inspector stationed at Fabens Mar. 23, 1930.³ Inspector stationed at Mercedes July 15, 1929.⁴ Inspector stationed at Naco Sept. 2, 1929.⁵ Inspector stationed at Presidio Mar. 20, 1930.⁶ Inspector stationed at Rio Grande City Mar. 25, 1930.⁷ Inspector stationed at Roma Feb. 1, 1930.⁸ Inspector stationed at Ysleta Mar. 9, 1930.⁹ Inspector stationed at Zapata Mar. 4, 1930.¹⁰ Expressed in numbers of fruits, tubers, etc., unless otherwise indicated under the column "Commodity."

There was considerable increase in the amount of certain fruits and vegetables which were imported from Mexico during the year. Eight thousand two hundred and fifty-seven cars of tomatoes, green peas, peppers, melons, and other vegetables and 3,677 cars of bananas consigned to various points in the United States were inspected and permitted entry. In addition considerable quantities of these fruits and vegetables were entered for local consumption under permits issued to the inspectors in charge at the various ports.

MARITIME-PORT INSPECTION

SHIP INSPECTION

Ships from foreign ports as well as from Porto Rico and Hawaii are inspected promptly upon arrival for the presence of prohibited plants and plant products in refrigerators, fruit and vegetable lockers, and passengers' and crews' quarters.

This service was extended during the year by placing inspectors at Bellingham, Wash., and Astoria, Oreg. Federal inspectors are stationed at the more important ports of entry with the exception of those located in California, Florida, Alabama, Mississippi, Hawaii, and several ports in Porto Rico. Inspection at these ports has been performed in a very efficient manner by State and Territorial officials serving as collaborators of the Plant Quarantine and Control Administration at a very small cost to the department.

A record, by ports, of the ship arrivals, ship inspections, and the number of ships carrying contraband plants and plant products appears in Table 19.

CARGO INSPECTION

All importations of plants and plant products subject to quarantine restrictions, with the exception of plant material imported under regulation 14 of quarantine No. 37 which was examined in Washington, D. C., or San Francisco, Calif., were inspected at port of entry or port of first arrival.

Table 20 indicates, by port, the number of shipments inspected and entered under permit and the number of shipments refused entry.

TABLE 20.—*Inspection of shipments of plants and plant products offered for entry, fiscal year 1930*

Port	Shipments inspected and entered under permit	Shipments refused entry	Port	Shipments inspected and entered under permit	Shipments refused entry
Baltimore.....	438	1	New York.....	17,448	36
Bellingham ¹	65	0	Norfolk.....	182	0
Boston.....	1,679	0	Philadelphia.....	1,162	27
Charleston.....	148	1	Portland, Oreg.....	63	1
Chicago.....	495	4	Porto Rico.....	1,329	1
Detroit.....	310	22	Providence.....	76	0
Galveston.....	249	0	San Diego ²	7	0
Houston.....	122	0	San Francisco ²	1,714	2
Honolulu ^{2 3}	436	191	San Pedro ²	544	100
Jacksonville ²	2	2	Savannah.....	91	0
Key West ²	1,657	5	Seattle.....	704	8
Los Angeles ²	46	1	Tampa ²	825	2
Miami ²	49	0			
Mobile ²	177	1			
New Orleans.....	2,968	2	Total.....	32,986	407

¹ Inspector stationed at Bellingham Sept. 9, 1929.

² Collaborators are stationed at these ports.

³ The records cover only the period July 1 to Apr. 30 of the fiscal year 1930.

In addition to inspection, certain commodities require disinfection as a condition of entry. Such treatment is given under supervision of inspectors of the administration at commercially operated plants. Material requiring treatment arriving during the year was as follows: Cotton, 304,794 bales (including 3,104 bales of linters) and 721 packages; cotton waste, 24,879 bales and 24 packages; bagging, 1,289 bales; tree seeds, 10,724 pounds, 203 cases and 120 packages; European chestnuts, 18,892 cases; and narcissus bulbs, imported under special permit, 484,178. Samples of cotton, cotton waste, and linters arriving by parcel post are also treated under similar supervision at commercial and Federal plants. During the year, 785 such parcels were treated at approved ports other than Washington, D. C.

Considerable time was devoted to the inspection of miscellaneous cargoes where examination was necessary to establish the true status of the shipment, and to the supervision of the cleaning by importers of products contaminated with objectionable material such as soil.

Inspections of ships' holds and docks for the presence of insects injurious to flour were performed at the ports of Galveston, Houston, New Orleans, Mobile, Pensacola, and Jacksonville. At Galveston 130 ship and 6 dock inspections were made; at Houston 80 ship and 80 dock inspections; at New Orleans 225 ship and 122 dock inspections; at Mobile 18 ship and 29 dock inspections; at Pensacola 11 ship inspections; and at Jacksonville 3 ship inspections.

INSPECTION OF SPECIAL PERMIT AND DEPARTMENTAL IMPORTATIONS

As in previous years, all plants imported under special permit have been inspected in Washington, D. C., and San Francisco, Calif. A tabular record of such importations is given on pages 70 and 71. All departmental importations and distributions from Washington, including domestic plants entering and leaving the District of Columbia, are likewise inspected and certified for shipment at the inspection house or in the nursery, freight, express, or post offices. A summary of this work is given in Table 21.

TABLE 21.—*Summary of plants and plant products offered for inspection in the District of Columbia, fiscal year 1930*

Material inspected	Foreign	Do- mestic	Fumi- gated	Other- wise treated	In- fested with insects	In- fected with diseases
Lots of seeds (departmental)-----	8,734	4,415	12,119	3,238	423	43
Plants, cuttings, bulbs, roots, rhizomes, etc. (depart- mental)-----	22,102	167,856	11,460	4,484	¹ 545	¹ 194
Miscellaneous unclassified material, other than plants and seeds (departmental)-----	72	23	33	5	4	2
Shipments of plants under regulation 14, quarantine 37 (commercial)-----	1,041	-----	105	85	158	160
Shipments of plants and plant products under regula- tions 3 and 15, quarantine 37 (commercial)-----	715	-----	471	24	26	20
Containers of domestic plants other than departmental (mail, express, and freight)-----	-----	11,190	-----	-----	-----	-----
Shipments of plants for distribution by U. S. Botanic Garden-----	-----	3,828	-----	-----	-----	-----
Shipments of plants by private individuals-----	-----	1,028	11	19	34	23
Interceptions of plants and plant products referred to Washington-----	806	-----	310	30	37	18
Cotton samples referred to Washington-----	15,244	-----	15,244	-----	-----	-----

¹ Lots.

FIELD INSPECTION OF PLANTS IMPORTED UNDER SPECIAL PERMIT

Plants imported under regulation 14, quarantine No. 37, in limited quantities for the purpose of keeping the country supplied with new, improved, or unavailable varieties and necessary propagating stock, or for experimental, educational, or scientific purposes are grown under special agreement with the department in 47 States. It is necessary to inspect these plants in the field to determine: (1) Freedom from important pests, particularly plant diseases, which may have escaped detection or which were in such an early stage of development as to make it impossible to recognize them at the initial inspection in Washington, D. C., or San Francisco, Calif., prior to shipment to the field; (2) whether the permittees are carrying out their agreement as to propagation; and (3) the rapidity of propagation and the probable date that the plants will be available in this country in sufficient quantities to make it unnecessary to continue to accept the pest risk which accompanies importations of the kind of plants involved.

During the past year 626 man-days were spent in examining special permit material grown by 992 permittees, located in 619 towns in 32 States. Inspections were made involving 71,748,273 plants, bulbs, etc., imported under 3,434 special permits. As a result of these inspections permittees were released from the obligations assumed in making application for 1,141 special-permit importations

which, with the increase produced over a period of two or more years, represent 60,929,092 plants, bulbs, etc.

Among the more important or little known diseases found as a result of the field inspections during the fiscal year were the following: A canker (*Phomopsis rudis*) on *Laburnum* spp. reported from Europe only, European rust (*Uromyces genistae-tinctoriae*) on leaves of *Genista fragrans*, iris rust (*Puccinia iridis*) on Dutch (bulbous) iris, and an apparently new disease of mosaiclike appearance on orchids (*Cymbidiums*). Additional data were also obtained on the severity and distribution of the mosaic diseases of bulbous iris and narcissus.

FOREIGN PARCEL-POST INSPECTION

The inspection of foreign parcel-post packages is performed in cooperation with the customs and post-office officials. All packages from foreign countries which are found to contain plants or plant products are referred to an inspector of the administration for examination. Foreign parcel-post packages containing plants or plant products arriving at ports where there are no representatives of the administration are forwarded by the postal officials to the nearest port at which an inspector is stationed.

A record of the inspection and disposition of foreign parcel-post packages containing plants and plant products appears in Table 22.

TABLE 22.—Number of inspections of foreign parcel-post packages, fiscal year 1930

Port	In-spected	Refused entry (entire or in part)	Di-verted to Wash-ington	Port	In-spected	Refused entry (entire or in part)	Di-verted to Wash-ington
Baltimore.....	144	53	74	New York.....	3, 076	612	872
Boston.....	1, 115	106	726	Philadelphia.....	9, 379	384	755
Chicago.....	9, 032	588	93	Portland, Oreg.....	45	6	26
Detroit.....	3, 428	350	232	Porto Rico.....	13	1	0
Houston.....	2	0	0	San Diego ¹	66	3	2
Honolulu ^{1 2}	1, 088	120	1	San Francisco ¹	4, 308	181	11
Jacksonville ¹	790	73	36	Seattle.....	173	94	4
Los Angeles ^{1 3}	3, 812	217	9	Tampa ¹	1	1	0
Miami ¹	17	16	0				
Mobile ¹	34	13	1	Total.....	36, 543	2, 828	2, 850
New Orleans.....	20	10	8				

¹ Collaborators are stationed at these ports.
² The records cover only the period July 1 to Apr. 30 of the fiscal year 1930.
³ In addition 98 packages were diverted to San Francisco for treatment.

INSPECTION IN PORTO RICO AND HAWAII

The inspection of foreign ships and plants and plant products arriving in Porto Rico has been performed by inspectors of the administration assisted by insular plant-quarantine inspectors serving as collaborators.

In addition the inspectors stationed in Porto Rico are charged with the enforcement of quarantine No. 58, which governs the movement of fruits and vegetables from that island to the mainland. Inspection of fruits and vegetables has been carried on in the fields, packing houses, and on the docks, and all shipments moving to the mainland have been certified as to freedom from pests.

Parcel-post packages originating in Porto Rico and destined for points on the mainland are examined for contraband plants and plant products. During the fiscal year 525 such packages were inspected. Of this number 100 were found to contain contraband plant material and were returned to the senders.

Table 23 shows, by months, the number of containers of fruits and vegetables inspected and certified for shipment.

TABLE 23.—*Number of containers of fruits and vegetables moving from Porto Rico to the mainland, inspected and certified under quarantine No. 58, fiscal year 1930*

Item	Inspected and certified during—						
	July	August	Septem-ber	October	Novem-ber	Decem-ber	January
Avocados.....		42	1	1			
Bananas ¹		1			523	1, 291	
Carrots.....					3		
Cucumbers.....					217	3, 116	839
Dasheens.....			3			20	12
Eggplants.....						323	1, 139
Ginger.....	50		9	7	82	30	1
Grapefruit.....	13, 239	7, 000	33, 207	144, 685	52, 214	67, 650	64, 484
Lemons.....			2	35	63	1	2
Lima beans.....						5	13
Limes.....	15	16	18	4			
Malangas.....							10
Mixed fruit.....	4	2	1	11	29	94	11
Oranges.....	1	47	844	15, 269	20, 533	28, 266	63, 617
Oranges, bitter.....						416	
Peppers.....	53			68	293	1, 023	732
Pineapples.....	25, 095½	16, 594	10, 460½	8, 766	4, 596	5, 820	4, 795
Plantains.....	1			1		1	
Pumpkins.....	7	24	36	103	44	84	45
Satsumas.....						1	
String beans.....					122	671	75
Squash.....			1		87	321	245
Sweet limes.....					7	5	
Tangerines.....					121	512	67
Tomatoes.....				50	874	2, 119	1, 328
Watermelons.....					1	62	73
Yautias.....						20	15
Total.....	38, 465½	23, 726	44, 582½	169, 000	79, 809	111, 851	137, 503
Certificates issued.....	216	225	226	429	312	475	504

Item	Inspected and certified during—					
	February	March	April	May	June	Total
Avocados.....					1	45
Bananas ¹			1, 240	2, 141	18, 684	23, 880
Carrots.....						
Chayotes.....		13	3	13		2
Cucumbers.....	155	102	28			4, 457
Dasheens.....		27	42	19	8	131
Eggplants.....	802	528	144	3	38	2, 977
Ginger.....	21	27	10	4		241
Grapefruit.....	76, 796	119, 147	207, 970	100, 622	73, 268	960, 282
Lemons.....						103
Lima beans.....	18	35				71
Limes.....				1	48	102
Malangas.....						10
Mixed fruit.....	27	5	6		3	193
Oranges.....	48, 492	23, 918	15, 583	574	1	217, 145
Oranges, bitter.....			17	20	1	454
Oranges, King.....	7	6	4			17
Peppers.....	627	1, 006	228	12	6	4, 048
Pineapples.....	14, 976	33, 220	197, 595	138, 135	49, 906	509, 959
Plantains.....						3
Pumpkins.....		90	40		1	474
Radishes.....			1			1
Satsumas.....						1
String beans.....	40					908
Squash.....	191	87	5			937
Sweet limes.....	2					14
Tamarinds.....			1	1		2
Tangerines.....	10					710
Tomatoes.....	1, 340	488	156			6, 355
Watermelons.....	133	10	2			281
Yautias.....			4			39
Total.....	143, 637	178, 709	423, 079	241, 545	141, 965	1, 733, 872
Certificates issued.....	472	439	809	436	326	4, 919

¹ Bunches.

The work in Hawaii relates principally to the enforcement of quarantine No. 13 on account of the Mediterranean fruit fly and the melon fly, and consists of the inspection and certification of such fruits and vegetables as are permitted to move to the mainland. A summary of the fruits and vegetables inspected and certified appears in Table 24.

TABLE 24.—*Number of containers of fruits and vegetables inspected and certified for shipment from Hawaii to the mainland, fiscal year 1930*

Month	Bananas ¹	Pine-apples	Taro	Coconuts	Ginger root	Lily root	Certificates issued
July.....	16, 728	1, 404	441	125	55	296	216
August.....	17, 447	872	777	32	84	395	220
September.....	13, 796	512	424	114	48	257	159
October.....	18, 300	325	221	180	197	275	128
November.....	19, 819	855	359	253	377	329	174
December.....	20, 675	1, 036	416	338	401	661	272
January.....	16, 566	1, 008	23	149	262	265	184
February.....	9, 878	982	60	16	77	192	137
March.....	9, 330	534	2	33	86	343	158
April.....	6, 858	311	-----	27	111	272	115
May.....	6, 655	687	89	176	80	215	180
June.....	6, 340	1, 607	390	77	116	162	163
Total.....	162, 392	10, 133	3, 202	1, 520	1, 894	3, 662	2, 106

¹ Bunches.

A baggage inspection service is maintained in Hawaii for the accommodation of travelers to the mainland. The baggage of passengers leaving on ships plying between Honolulu and mainland ports only is inspected and sealed, thus eliminating delay incident to baggage inspection at destination. During the year 2,419 pieces of baggage were inspected and sealed.

INSPECTION OF PLANT-INTRODUCTION AND PROPAGATING GARDENS

As heretofore, plants for distribution by the Bureau of Plant Industry from its plant-introduction and propagating gardens were inspected and certified prior to shipment. Plants shipped from Mandan, N. Dak., and Chico, Calif., were inspected by officials of the States concerned serving as collaborators of the administration. Those distributed from Chapman Field, Fla., and Savannah, Ga., were examined by inspectors of the administration in cooperation with officials of the States of Florida and Georgia likewise serving as collaborators. Table 25 indicates the number of plants inspected and certified for distribution.

TABLE 25.—*Number of plants, bud sticks, cuttings, tubers, roots, and shipments of seeds examined for distribution from plant-introduction and propagating gardens, fiscal year 1930*

Station	Plants	Bud sticks, cuttings, tubers, and roots	Shipments of seeds
Bell.....	30, 901	681	-----
Chico.....	21, 099	816	121
Chapman Field.....	2, 463	29	15
Savannah.....	14, 513	2, 388	2
District of Columbia.....	3, 379	8, 143	9, 947
Mandan, N. Dak. ¹	266, 179	-----	-----
Total.....	338, 534	12, 057	10, 085

¹ The figures given are from the Office of Dry Land Agriculture, Bureau of Plant Industry. All other figures in the table are from the report of the Office of Foreign Plant Introduction to the Chief of the Bureau of Plant Industry.

PESTS INTERCEPTED

During the fiscal year the inspectors and collaborators of the administration collected on or in foreign plants and plant products 577 recognized species of insects and 501 insects which could be assigned to family or genus only, 108 recognized species of fungi and bacteria, and 8 recognized species of nematodes. In addition there were a large number of interceptions of fungi, bacteria, and nematodes which could be referred to the genus or family only. Many of these interceptions were of considerable economic or scientific importance.

The West Indian fruit fly (*Anastrepha fraterculus*) was intercepted in mango from Dominica, mango and orange from Honduras, guava from Jamaica, and guava, mango, and pomegranate from Porto Rico; the Mexican fruit fly (*A. ludens*) in avocado, guava, mamey, mango, orange, pear, and yellow plum from Mexico; *A. striata* in guava from Cuba, and in cardboard box containing guavas from Dominican Republic; *Anastrepha* sp. in mango from the Canal Zone, Guatemala, Mexico, and Porto Rico, guava from Cuba and Dominican Republic, and sapodilla from Trinidad. The melon fly (*Bactrocera cucurbitae*) was taken in cucumber from Hawaii. The Mediterranean fruit fly (*Ceratitis capitata*) was intercepted in orange and *Sorbus* sp. from the Azores, green pepper (*Capsicum annuum*) from Bermuda, orange from Brazil, dry fruit of *Cotoneaster praecox* from France, avocado, mango, and orange from Hawaii, pepper (*Capsicum annuum*) from India, olive, orange, pricklypear, and tangerine from Italy, loquat, pear, and pricklypear from the Maderia Islands, apple, on outside of grape, orange, and in the bottom of a box of oranges from Spain. The olive fly (*Dacus oleae*) was taken in olive from Italy.

The dagger moth (*Acronycta auricoma*) was intercepted on mahaleb, myrobalan plum, and pear stocks from France; the sorrel cutworm (*A. rumicis*) on cherry, mahaleb, Manetti, and plum stocks from France and Manetti from the Netherlands; *Acronycta* sp. on fruit stocks from France; and the white tree pierid (*Aporia crataegi*) on mahaleb, Manetti, myrobalan plum, pear, and *Rosa multiflora* stocks from France. *Calophasia lunula* was taken on Manetti and *R. multiflora* stocks from France. The sawfly (*Emphytus cinctus*) was found in Manetti from England, France, Ireland, and the Netherlands, and in *R. multiflora* from France. The European tussock moth (*Notolophus antiqua*) arrived on *R. multiflora* from the Netherlands.

The pink bollworm (*Pectinophora gossypiella*) was intercepted in cotton from China and Egypt, *Gossypium* sp. and seed cotton from Chosen, cottonseed from Haiti, India, Italy, Malta, and Porto Rico, cotton (raw boll) and cotton (raw) from Hawaii, and in cotton sample from Mexico. The gold-tail moth (*Porthesia similis*) arrived with azalea from the Netherlands. Lima and string beans from Cuba were infested with the bean pod borer (*Maruca testulalis*). The mango weevil (*Sternuchus mangiferae*) was intercepted in mango seed from Hawaii and India. The west Indian sweetpotato weevil (*Euscepes batatae*) was found in sweetpotato and yam from Brazil and in yam from Jamaica. *Euscepes* sp. was intercepted in sweetpotato from Panama. The Philippine orange moth (*Prays citri*) arrived with grapefruit from the Philippines. Rice straw packing from Japan was infested with the sugarcane moth borer of India (*Chilo simplex*). *Apion carduorum* was taken in globe artichoke

from France. Turnips from England were infested with the turnip gall weevil (*Ceutorhynchus pleurostigma*) and *Psylliodes chrysocephala*. Turnips from France and Portugal were infested with *Baris laticollis*. *Brachycerus albidentatus* was intercepted in garlic from Italy and *B. algirus* arrived with garlic from Spain. *Stenoma anonella* was taken in soursop from the Canal Zone. *Exosoma lusitanica* was intercepted in cipollino from Morocco. *Acythopeus aterrimus* arrived with orchids from the Philippines. The citrus blackfly (*Aleurocanthus woglumi*) was found on various hosts from Costa Rica, Cuba, Haiti, and Jamaica. *Conotrachelus aguacatae* and *Heilipus perseae* were intercepted in avocados from Mexico. *Conotrachelus* sp. was taken in avocados from Honduras and Mexico, and *Heilipus* sp. in avocados from the Canal Zone and Mexico. *Balaninus* sp. infested chestnuts from China, England, France, Italy, Japan, and Portugal. *Curculio* sp. was intercepted in chestnuts from Russia. *Laspeyresia splendana* was taken in chestnuts from China, Italy, and Japan; *L. splendana reaumurana* in chestnuts from France, Italy, Portugal, and Spain; and *Laspeyresia* sp. in chestnuts from Japan. *Eumerus* sp. was intercepted in onions from Egypt, England, and the Netherlands, *Lilium candidum* from France, and hyacinth, narcissus, and snowdrop from the Netherlands. *Merodon* sp. arrived with cipollino from Italy and Morocco, narcissus from England and the Netherlands, and snowdrop from the Netherlands.

The fungus causing Lima-bean scab, tentatively diagnosed as *Elsinoe canavaliae*, was found in numerous shipments of Lima beans from Cuba and in similar shipments from Porto Rico. *Colletotrichum lindemuthianum* (anthracnose), the conidial stage of *Diaporthe phaseolorum* (pod blight) and *Bacterium phaseoli* (bacterial blight) were intercepted with the *Elsinoe* in the same shipments.

Sphaceloma rosarum was found on cuttings of roses from Spain and Ireland. Another species of *Sphaceloma*, causing a fruit spot, was intercepted on apples from England, Ireland, and Italy. A third species of *Sphaceloma*, causing a scab, was found on avocados from Mexico.

Actinomyces sp. (raised scab) was intercepted on potatoes from Denmark and Estonia; *Aspergillus alliaceous* was found on garlic from Italy; *Bacillus leguminiperdus* on peas from South Africa; *Bacterium atrofaciens* (basal glume rot) on wheat from Italy; *Bacterium citri* (citrus canker) on orange from the Philippines, China, and Japan, on pomelo from China, and on sweet lime from the Philippines; *B. savastanoi* (olive knot) on olive cutting from Italy; *Cerebella andropogonis* on seed of *Brachiaria* sp. and *Sorghum lanceolatum* from Sudan; *Ceretostomella* sp. on waterchestnut from China; *Colletotrichum falcatum* (red rot) on sugarcane from Cuba and Hawaii; *Diplodia tubericola* on kudzu roots from China; *Fusicladium eriobotryae* (scab) on loquat from Italy; *Macrosporium tomato* (nailhead spot) on tomato from Mexico, Bahamas, and France; *Oidium euonymi-japonici* (mildew) on *Euonymus* sp. from Japan; *Phoma citricarpa* (black spot) on orange from China and Japan; *Phragmotrichum chailletii* on fir cone from Sweden; *Physopella ficis* (rust) on fig from Cuba; *Puccinia allii* (rust) on garlic from Italy; *P. buxi* (rust) on boxwood from England; *P. cynodontis* (rust) on *Bromus* sp. and *Cynodon* sp. from Russia; *P. ornithogali-thyrsoidis* (rust) on chincherichee from South Africa; *Sphacelotheca reilianum* (smut) on broomcorn from Russia.

Tylenchus angustus was intercepted in hay found in the tail gear of an airplane from Mexico; *T. dipsaci* was intercepted in cut flowers of narcissus from Canada and in potato from Belgium, as well as in iris, narcissus, and muscari bulbs from the Netherlands and narcissus bulb from the Isle of Guernsey.

A total of 5,149 interceptions of insects and plant diseases was forwarded to Washington for determination by inspectors and collaborators during the fiscal year. In addition, the collaborators in California, Florida, and Hawaii made 4,718 interceptions of insects and 28 plant diseases, 458 interceptions of insects and 204 plant diseases, and 113 interceptions of insects, respectively, which were identified by State and insular authorities. (Table 26.) The figures given for Florida represent interceptions made during the first nine months of the fiscal year.

TABLE 26.—Number of interceptions of insects and plant diseases forwarded to Washington for identification, fiscal year 1930

Port	Cargo		Stores		Baggage		Mail		Quarters		Total	
	In-sects	Dis-eases	In-sects	Dis-eases	In-sects	Dis-eases	In-sects	Dis-eases	In-sects	Dis-eases	In-sects	Dis-eases
Astoria ¹	0	0	2	1	0	0	0	0	1	0	3	1
Baltimore.....	23	4	21	30	0	0	6	2	7	0	57	36
Bellingham ²	11	2	0	0	0	0	0	0	0	0	11	2
Boston.....	16	1	60	7	55	0	23	0	3	0	157	8
Brownsville.....	1	0	0	0	25	3	0	0	0	0	26	3
Calexico.....	1	0	0	0	0	0	0	0	0	0	1	0
Charleston.....	253	2	161	129	0	0	0	0	19	11	433	142
Chicago.....	2	0	0	0	0	0	3	2	0	0	5	2
Del Rio.....	1	0	0	0	3	2	0	0	1	0	5	2
Detroit.....	59	38	0	1	12	1	59	17	0	0	130	57
Douglas.....	1	0	0	0	0	2	0	0	0	0	1	2
Eagle Pass.....	12	3	3	0	24	0	0	0	0	0	39	3
El Paso.....	3	0	0	0	43	28	6	0	1	0	53	28
Galveston.....	3	1	0	0	0	0	0	0	0	0	3	1
Hawaii.....	87	1	6	0	96	0	34	0	10	0	233	1
Hidalgo.....	3	1	0	0	16	0	0	0	0	0	19	1
Houston.....	1	0	0	0	3	2	0	0	0	0	4	2
Laredo.....	3	1	0	0	12	1	1	0	0	0	16	2
Los Angeles.....	1	0	0	0	0	0	0	0	0	0	1	0
Mobile.....	34	0	12	0	3	1	1	0	1	0	51	1
Naco.....	0	0	0	0	5	1	0	0	0	0	5	1
New Orleans.....	123	21	43	17	17	3	2	0	12	3	197	44
New York.....	798	244	23	9	112	31	24	17	1	0	958	301
Nogales.....	66	25	0	0	15	0	0	0	0	0	81	25
Philadelphia.....	107	64	508	79	56	6	120	26	83	22	874	197
Portland, Oreg.....	7	2	0	0	0	0	0	0	3	0	10	2
Roma.....	1	0	0	0	6	3	0	0	0	0	7	3
San Francisco.....	11	0	0	0	1	0	1	0	3	0	16	0
San Juan.....	8	0	2	0	3	0	0	0	2	1	15	1
San Ysidro.....	8	0	0	0	4	0	0	0	0	0	12	0
Savannah.....	2	0	3	2	0	0	0	0	0	0	5	2
Seattle.....	32	2	43	11	25	13	4	0	10	4	114	30
Thayer.....	0	1	0	0	7	0	0	0	0	0	7	1
Washington, D. C., inspection house.....	117	66	0	0	0	0	415	68	0	0	532	134
Miscellaneous.....	19	2	1	0	4	0	6	0	0	0	30	2
Total.....	1,814	481	888	286	547	97	705	132	157	41	4,111	1,037

¹ Inspector stationed at Astoria May 10, 1930.

² Inspector stationed at Bellingham Sept. 9, 1929.

NOTE.—Inspectors stationed in Porto Rico made 109 interceptions of insects and 9 of diseases during their field and packing-house inspection of fruits and vegetables for shipment to the mainland.

INTERCEPTIONS OF PROHIBITED PLANTS AND PLANT PRODUCTS

A record of contraband plants and plant products intercepted in baggage, mail, cargo, stores, and quarters by inspectors and collaborators of the administration at the various maritime ports is given in Table 27.

TABLE 27.—*Number of interceptions of contraband plants and plant products, fiscal year 1930*

Port	In baggage	In mail	In cargo	In stores	In quarters
Astoria ¹	0	0	0	0	0
Baltimore.....	2	54	2	21	104
Bellingham ²	422	0	0	0	0
Boston.....	200	147	1	5	2
Charleston.....	0	0	3	19	67
Chicago.....	0	590	0	0	0
Detroit.....	61	371	58	0	0
Galveston.....	21	0	5	80	7
Gulfport ³	0	0	0	0	0
Houston.....	517	0	0	36	0
Honolulu ^{3 4}	2, 360	21	28	4	1
Jacksonville ³	2	70	1	21	1
Key West ³	1, 544	0	0	0	0
Los Angeles ³	1	62	0	0	0
Miami ³	1, 379	9	0	115	1, 091
Mobile ³	13	3	2	31	63
Newport News ³	0	0	0	0	0
New Orleans.....	52	5	5	196	588
New York ⁵	3, 314	720	39	11	136
Norfolk.....	0	0	0	0	0
Pascagoula ³	0	0	0	0	0
Pensacola ³	0	0	0	24	5
Philadelphia.....	49	455	36	223	157
Portland, Oreg.....	5	6	0	1	1
Porto Rico.....	290	0	3	147	22
Providence.....	444	0	4	0	0
San Diego ³	19	0	4	48	41
San Francisco ³	479	51	31	205	196
San Pedro ³	168	0	2	132	36
Savannah.....	0	0	0	0	0
Seattle.....	424	55	0	0	0
Tampa ³	19	0	6	41	97
Total.....	11, 785	2, 619	230	1, 360	2, 615

¹ Inspector stationed at Astoria May 10, 1930.² Inspector stationed at Bellingham Sept. 9, 1929.³ Collaborators are stationed at these ports.⁴ The records cover the period July 1 to Apr. 30 of the fiscal year 1930.⁵ In addition 1219 interceptions were made in appraisers' stores and 145 in Porto Rican express.

RECORDS OF IMPORTS OF RESTRICTED PLANTS AND PLANT PRODUCTS

Under various foreign quarantines certain plants and plant products are restricted as to entry and made subject to inspection and, if necessary, disinfection, for the purpose of excluding various plant diseases and insect pests. Among such restricted plants and plant products are nursery stock, plants and seeds for propagation, fruits and vegetables, grains from certain countries, brooms, broomcorn, cotton, cotton waste, cotton wrappings (bagging), and cottonseed products; also, cottonseed, seed cotton, and cottonseed hulls from the Imperial Valley, Lower California, Mexico. The records of the importations of these articles are indicated in the discussion and tables which follow.

IMPORTATIONS OF NURSERY STOCK, PLANTS, AND SEEDS

The importations recorded in Tables 28 to 32, inclusive, are entered under regulation 3 of quarantine No. 37, under permits which are made continuing and unlimited as to the quantity that may be imported. The restrictions under this regulation are intended merely to afford opportunity to inspect, and if necessary, to safeguard the products as they are entered. In the case of Table 28, the entries made during the preceding year are also listed for the purpose of comparison, and in Table 30 the bulb entries of the preceding eight years are brought together to show the fluctuation in the entry of different classes of bulbs.

TABLE 28.—*Importation of fruit, rose, and nut stocks, cuttings, and scions under regulation 3, quarantine No. 37, fiscal year 1930*

[Figures indicate number of plants]

Kind of stocks, cuttings, and scions	Argentina	Australia	Austria	Canada	Canal Zone	Chile	England	France	Germany	Greece
Apple				487			2, 187	2, 499, 600	2, 982	
Apricot		71								
Cherry							650	6, 662, 550	100	
Grape	18					6			354	28
Nut			1, 000					15, 700	512	
Pear							106	1, 536, 750	31	
Plum							306	705, 550		
Quince								259, 900		
Rose							2, 062, 500	1, 042, 750	10, 000	
Miscellaneous fruits					15		6			
Total	18	71	1, 000	487	15	6	2, 065, 755	12, 722, 800	13, 979	28

Kind of stocks, cuttings, and scions	Hungary	Ireland	Italy	Mexico	Netherlands	Norway	Rumania	Switzerland	Total	
									1930	1929
Apple					22			1, 250	2, 506, 528	2, 234, 360
Apricot								71	71	60
Avocado				3, 926					3, 926	
Cherry								450	6, 663, 750	6, 610, 489
Cranberry						200			200	
Fig			217						217	82
Grape	400		491				10		1, 307	4, 055
Nut									17, 212	25, 402
Olive										25
Peach										3
Pear					29				1, 536, 916	1, 021, 325
Persimmon										2, 000
Plum			120, 000						825, 856	925, 706
Prune										2, 000
Quince								750	260, 650	289, 246
Rose		112, 000			7, 979, 480				11, 206, 730	10, 991, 337
Miscellaneous fruits									21	
Total	400	112, 000	120, 708	3, 926	7, 979, 531	200	10	2, 450	23, 023, 384	22, 106, 090

TABLE 29.—*Importation of bulbs under regulation 3, quarantine No. 37, fiscal year 1930*

[Figures indicate number of bulbs]

Bulbs	Azores	Bermuda	Canada	China	England	France	Germany	India	Ireland
Chionodoxa					89				
Convallaria					12	2, 000	23, 317, 739		
Crocus					8, 637				72
Eranthis					638				
Fritillaria					524	3			12
Galanthus					6, 536				12
Hyacinth					157	533, 820	4		
Ixia					156				
Lily	300	938, 513	619	3, 905	68, 031	972, 719	21, 731	1, 340	10
Muscari					551				25
Scilla					8, 643		12		
Tulip			200		11, 425	112, 750	103		25
Total	300	938, 513	819	3, 905	105, 399	1, 621, 292	23, 339, 589	1, 340	156

Bulbs	Italy	Japan	Netherlands	Palestine	Philippine Islands	Scotland	Spain	Switzerland	Total
Chionodoxa			476, 283			50			476, 422
Convallaria			341, 485						23, 661, 236
Crocus			8, 066, 661	69					8, 075, 439
Eranthis			187, 973						188, 611
Fritillaria		140	122, 020						122, 699
Galanthus			744, 975						751, 523
Hyacinth			19, 721, 047			25		4	20, 255, 057
Ixia			461, 096						461, 252
Lily	42, 000	18, 233, 552	453, 535		1, 144	29			20, 737, 428
Muscari			1, 472, 879						1, 473, 455
Scilla			1, 536, 189	12		25	2	6	1, 544, 889
Tulip	750	1, 200	163, 478, 309			150			163, 604, 912
Total	42, 750	18, 234, 892	197, 062, 452	81	1, 144	279	2	10	241, 352, 923

TABLE 30.—*Summary of bulb importations under regulation 3, Quarantine No. 37, for fiscal years 1923-1930*

[Figures indicate number of bulbs]

Bulbs	1923	1924	1925	1926	1927	1928	1929	1930
Chionodoxa ¹		339,766	465,422	839,637	466,872	439,075	487,228	476,422
Convallaria	19,603,092	17,568,835	18,980,311	20,543,785	20,558,460	24,738,880	23,087,167	23,661,236
Crocus	8,286,500	10,815,920	10,624,670	10,898,968	9,969,070	8,775,467	9,886,546	8,075,439
Eranthis ¹		93,314	152,787	214,173	144,156	135,842	143,592	188,611
Fritillaria ¹		92,951	104,483	209,543	125,688	111,778	115,658	122,699
Galanthus ¹		797,381	895,003	1,128,335	844,544	662,989	718,130	751,523
Hyacinth	29,142,797	32,197,740	27,947,261	23,682,560	23,711,178	22,127,888	21,450,547	20,255,057
Ixia ¹		335,158	371,983	545,278	529,404	704,644	827,154	461,252
Lily	9,145,630	9,690,486	11,207,559	16,031,090	16,228,762	19,917,477	21,453,024	20,737,428
Muscari ¹		612,329	906,259	1,404,573	993,339	1,150,220	1,639,982	1,473,455
Narcissus	77,193,281	92,659,666	106,314,049	142,384,199	(²)	(²)	(²)	(²)
Scilla ¹		994,762	1,742,514	2,012,750	1,553,313	1,341,685	1,436,988	1,544,889
Tulip	76,719,116	92,539,157	96,290,452	106,849,572	129,681,036	161,940,818	191,959,162	163,604,912
Unclassified	183,900				11,112			
Total	220,274,316	258,737,465	276,002,753	326,744,463	204,816,928	242,046,763	273,205,178	241,352,923

¹ Imported under regulation 14, quarantine No. 37, from June 1, 1919 to Jan. 1, 1923.² Imported under regulation 14, quarantine No. 37, since Jan. 1, 1926.TABLE 31.—*Importation of tree seeds under regulation 3, Quarantine No. 37, fiscal year 1930*

[Figures indicate number of pounds]

Country of origin	Apple	Banana	Cherry	Elm	Grape	Nut and palm	Ornamental and tree	Peach	Pear	Persimmon	Plum	Rose	Miscellaneous	Total
Africa							11							11
Australia						24,461	35						1	24,497
Austria	1,009		685	11		1	10,416		381		90	13		12,606
Brazil						243	202							445
British Honduras						15	4							19
Canada						3	883							886
Canal Zone							2						1	3
Canary Islands							91							91
Ceylon						9	4						1	14
China				1,124		347	6,281	50	328	2			11	8,143
Costa Rica							4							4
Cuba						199								199
Czechoslovakia	100		505				392		140		9			1,146
Denmark							894					16		910
Dominican Republic						3								3
Egypt						4								4
England							3							3
France	11,333		1,655	40		74	2,495		1,063		41			16,701
Germany	17			21		1	4,267				55	52		4,413
Guam						1	115							116
India						1	9							10
Ireland							13							13
Italy						37	1,783							1,820
Japan					10	867	12,360		1,033	26	22	952		15,270
Java						4	6							10
Madagascar							4							4
Manchuria							35							35
Mauritius Island						24	2							26
Mexico		40					44							84
Netherlands							33							33
New Guinea						1								1
New Zealand							2							2
Philippine Islands							58						3	61
Poland							34							34
Russia							10							10
Scotland							82							82
Siam							1							1
Sweden							57							57
Switzerland						20								20
Trinidad						249	11							260
Yugoslavia							6							6
Total	12,459	40	2,845	1,196	10	26,564	40,649	50	2,945	28	217	1,033		17,88,053

NOTE: In addition to the seeds above indicated in pounds, 193 packets of miscellaneous seeds were imported from numerous countries. These packets contained seeds ranging in weight from a fraction of an ounce to several ounces. 2,200 pounds of onion sets also were imported from Greece for seed purposes.

TABLE 32.—*Distribution by States of bulbs, nursery stock, and seeds imported under regulation 3, quarantine No. 37, fiscal year 1930*

State	Bulbs	Stocks, cuttings and scion				Seeds						
		Fruit	Nut	Rose	Total	Elm	Fruit	Nut and palm	Ornamental and tree	Rose	Miscellaneous	Total
		No.	No.	No.								
	<i>Cases</i>					<i>Lbs.</i>	<i>Lbs.</i>	<i>Lbs.</i>	<i>Lbs.</i>	<i>Lbs.</i>	<i>Lbs.</i>	
Alabama.....	360						25		322			347
Arizona.....	29											
Arkansas.....	135											
California.....	7, 115	90, 827	500	7, 500	98, 827	1	58	8, 422	706	50	11	9, 248
Colorado.....	831			46, 100	46, 100	290	419	2	7			718
Connecticut.....	2, 473	945, 224		796, 100	1, 741, 324		510		1, 304	323		2, 137
Delaware.....	438	175			175				3			3
District of Columbia.....	706			24, 900	24, 900				198			198
Florida.....	349	15			15			277	211			488
Georgia.....	740					223	35	255	3, 200	72	1	3, 786
Idaho.....	56											
Illinois.....	23, 932	25, 400		1, 085, 150	1, 110, 550			51	7, 032	11		7, 094
Indiana.....	1, 302	644, 000		1, 452, 875	2, 096, 875	20		2	758			780
Iowa.....	1, 117	2, 424, 020	1, 000	190, 500	2, 615, 520	50	323		458	5		836
Kansas.....	480	433, 000			433, 000		7, 928		1, 080			9, 008
Kentucky.....	581			10, 000	10, 000				6			6
Louisiana.....	246								180			180
Maine.....	387								17			17
Maryland.....	1, 096	376, 854		21, 000	397, 854			178	28	1		207
Massachusetts.....	4, 918	4, 500		90, 800	95, 300			5	93			98
Michigan.....	4, 542	76, 000		150, 850	226, 850		1	6	343			350
Minnesota.....	1, 731			10, 000	10, 000	140	10		393			543
Mississippi.....	124								25			25
Missouri.....	2, 251	516, 000		95, 000	611, 000		2, 015	122	16			2, 153
Montana.....	127											
Nebraska.....	378	85, 015			85, 015		10		104	14		128
Nevada.....	2											
New Hampshire.....	158			5, 000	5, 000			3	287			290
New Jersey.....	7, 692	10, 078		798, 550	808, 628		72	4, 029	913	76		5, 090
New Mexico.....	27											
New York.....	67, 662	5, 192, 831	4, 700	3, 764, 140	8, 961, 671		1, 540	8, 875	4, 169			14, 584
North Carolina.....	504								503			503
North Dakota.....	70					5			1			6
Ohio.....	6, 353	512, 440	8, 000	2, 219, 550	2, 739, 990	7	1	233	1, 158	13		1, 412
Oklahoma.....	294	40, 000			40, 000		30		146			176
Oregon.....	954	130, 431	1, 012	75, 000	206, 443		1, 293	200	77			1, 570
Pennsylvania.....	16, 054	45, 742	2, 000	127, 600	175, 342	166	1, 452	1, 700	8, 301	146		11, 765
Rhode Island.....	1, 545	19, 000		51, 115	70, 115				1			1
South Carolina.....	309								1			1
South Dakota.....	74	200			200							
Tennessee.....	964	141, 000		50, 000	191, 000		37	75	88			200
Texas.....	669	44, 926		10, 000	54, 926	77	22	120	335	1	5	560
Utah.....	253	35, 028		10, 000	45, 028							
Vermont.....	291								40			40
Virginia.....	1, 022			20, 000	20, 000			302	49			351
Washington.....	1, 952	6, 736		500	7, 236	22	2, 440	179	506	10		3, 157
West Virginia.....	404											
Wisconsin.....	2, 463			94, 500	94, 500		15	3	226			244
Wyoming.....	14											
Various States.....						195	358	1, 172	7, 353	311		9, 389
Exported by permittee.....	1, 046							353	11			364
Total.....	167, 220	11, 799, 442	17, 212	11, 206, 730	23, 023, 384	1, 196	18, 594	26, 564	40, 649	1, 033	17	88, 053

NOTE.—In addition to the seeds above indicated in pounds, 193 packets of miscellaneous seeds were imported from numerous countries. These packets contained seeds ranging in weight from a fraction of an ounce to several ounces; 2,200 pounds of onion sets also were imported from Greece for seed purposes.

The record of entry under special permits issued under the provisions of regulation 14 of quarantine No. 37 for the purpose of keeping the country supplied with new, improved, or unavailable varieties and necessary propagating stock and for experimental, educational, or scientific purposes is given in Table 33.

TABLE 33.—*Special-permit importations, fiscal year 1930, with combined total for fiscal years 1920–1930*

Class of plants	Fiscal year 1930				Total for fiscal years, 1920–1930			
	Permits issued		Importations under permits		Permits issued		Importations under permits	
	Num- ber	Quantity authorized	Num- ber	Quantity imported	Num- ber	Quantity authorized	Num- ber	Quantity imported
Dahlia.....	50	3, 671	53	2, 898	653	51, 807	554	36, 484
Gladiolus.....	121	47, 129	108	25, 464	1, 628	50, 534, 635	1, 358	28, 534, 307
Iris, bulbous.....	125	2, 715, 846	74	1, 257, 815	1, 315	47, 713, 184	1, 068	32, 799, 646
Iris, rhizomatous.....	67	6, 802	78	4, 418	1, 320	268, 970	1, 153	139, 699
Narcissus.....	159	7, 528, 476	97	484, 178	1, 055	153, 799, 122	808	69, 531, 375
Orchid.....	199	11, 264	188	9, 634	1, 428	197, 884	1, 271	150, 347
Peony.....	96	19, 457	90	14, 780	1, 147	1, 388, 339	929	674, 289
Rose.....	109	16, 813	109	10, 394	1, 144	232, 838	970	166, 247
Fruit (trees and small fruits).....	6	620	6	394	146	15, 670	101	7, 405
Herbaceous.....	127	39, 546	115	25, 395	1, 289	4, 759, 305	1, 030	2, 953, 364
Miscellaneous bulbs, roots, etc.....	118	240, 444	106	167, 666	1, 415	12, 730, 990	1, 230	6, 622, 331
Ornamental.....	221	587, 026	191	68, 363	1, 670	3, 811, 977	1, 324	2, 171, 763
Total.....		11, 217, 094		2, 071, 399		275, 504, 721		143, 787, 257

NOTE.—The disparity in the number of bulbs, plants, etc., imported as compared with the number authorized entry may be explained by the fact that permits for some classes of plants, particularly narcissus and bulbous iris, are usually issued during one fiscal year and the importations made during the following fiscal year.

During the year 1,300 such permits were issued authorizing the entry of 11,217,094 plants and bulbs. A total of 2,071,399 plants and bulbs was imported under 1,064 permits as compared with a total of 17,971,647 plants and bulbs imported during 1929. Narcissus importations decreased from 12,769,835 to 484,178, bulbous iris from 4,119,775 to 1,257,815, gladiolus from 463,087 to 25,464, and all other classes showed considerable decreases in the numbers imported as compared with importations in 1929 with the exception of fruits (trees and small fruits) importations of which increased from 350 to 394 plants. A summary of special permits issued during the entire period of the quarantine to date is given in Table 34. The total importations during the past year were much less than during any other year since quarantine No. 37 became effective.

TABLE 34.—*Special-permit importations, yearly totals for fiscal years 1920–1930*

Fiscal year	Permits issued		Importations under permits	
	Number	Quantity authorized	Number	Quantity imported
1920.....	311	10, 752, 844	171	3, 484, 195
1921.....	622	13, 965, 013	411	8, 132, 634
1922.....	750	9, 573, 199	518	3, 344, 026
1923.....	897	15, 175, 003	719	10, 357, 406
1924.....	1, 107	15, 381, 621	862	12, 561, 306
1925.....	1, 235	9, 517, 913	1, 087	8, 575, 129
1926.....	1, 445	80, 982, 954	1, 200	6, 021, 508
1927.....	1, 453	54, 006, 343	1, 256	46, 624, 587
1928.....	1, 602	37, 953, 209	1, 357	24, 643, 420
1929.....	1, 353	16, 979, 528	1, 348	17, 971, 647
1930.....	1, 300	11, 217, 094	1, 064	2, 071, 399
Total.....	12, 075	275, 504, 721	9, 993	143, 787, 257

NOTE.—The disparity in the number of bulbs, plants, etc., imported as compared with the number authorized entry may be explained by the fact that permits for some classes of plants, particularly narcissus and bulbous iris, are usually issued during one fiscal year and the importations made during the following fiscal year.

The number of varieties considered has now reached a total of 51,071 (an increase of more than 5,000 during the year), of which 48,921 have been approved for entry. Table 35 shows the distribution of these varieties among the various classes of plants as well as a comparison of the 1930 importations with those of 1929 for each class. The distribution of the imported special permit material by States is shown in Table 36.

TABLE 35.—*Special-permit material: Number of different varieties of plants requested and approved for fiscal years 1920–1930, and comparison of importations for fiscal years 1929 and 1930*

Class of plants	Variety of plants requested and approved, 1920–1930			Comparison of importations	
	Requested	Approved	Percentage approved	1929	1930
Dahlia.....	3, 270	3, 127	95. 63	3, 757	2, 898
Gladiolus.....	1, 932	1, 798	93. 06	463, 087	25, 464
Iris, bulbous.....	524	523	99. 81	4, 119, 775	1, 257, 815
Iris, rhizomatous.....	2, 697	2, 550	94. 55	8, 602	4, 418
Narcissus.....	1, 890	1, 880	99. 47	12, 769, 835	484, 178
Orchid.....	10, 142	10, 117	99. 75	12, 066	9, 634
Peony.....	2, 175	1, 924	88. 46	26, 699	14, 780
Rose.....	4, 476	4, 043	90. 33	18, 905	10, 394
Fruit (trees and small fruits).....	334	319	95. 51	350	394
Herbaceous.....	6, 398	6, 212	97. 09	49, 646	25, 395
Miscellaneous bulbs, roots, etc.....	3, 248	3, 208	98. 77	377, 774	167, 666
Ornamental.....	13, 985	13, 220	94. 53	121, 151	68, 363
Total.....	51, 071	48, 921	95. 79	17, 971, 647	2, 071, 399

TABLE 36.—*Distribution of special-permit material by States for fiscal years 1920–1930*

State or Territory	Dahlia	Gladiolus	Iris, bulbous	Iris, rhizomatous	Narcissus	Orchid	Peony
Alabama.....		15, 115	30, 980		6, 000		
Arizona.....	14	12			1, 000	14	
Arkansas.....			18, 000				
California.....	6, 284	1, 926, 653	10, 792, 904	30, 440	5, 521, 555	35, 874	2, 751
Colorado.....	58	31, 391	33, 490			2, 003	150
Connecticut.....	1, 053	16, 154	22, 745	1, 535	32, 185	318	113
Delaware.....		2, 000	169, 300	22	28	1, 611	1, 018
District of Columbia.....	166	516	215	93	98	298	
Florida.....		48, 930	306, 617		6, 913, 730	123	
Georgia.....	360	9, 210	171, 485	181	11, 696		
Idaho.....		862	2, 534	24			
Illinois.....	123	3, 255, 696	891, 390	15, 032	221, 025	994	46, 280
Indiana.....	186	2, 389, 804	502, 732	2, 964	1, 196	360	7, 689
Iowa.....		112, 201	10, 035	6	250		24, 012
Kansas.....	99		32	2, 263	141		3, 059
Kentucky.....	408		51, 200		437	415	133
Louisiana.....	116	2, 500	21, 750		10, 363	1, 332	
Maine.....		350		43			262
Maryland.....	519	23, 065	447, 075	413	1, 122, 196	560	20, 270
Massachusetts.....	1, 755	3, 442, 668	509, 051	3, 435	101, 680	25, 986	6, 743
Michigan.....	4, 453	12, 374, 274	1, 057, 766	3, 404	2, 346, 777	542	87, 476
Minnesota.....	49	86, 946	306	3, 009	11, 000	665	7, 549
Mississippi.....	49	6, 500	49, 776	9	7, 275		
Missouri.....	253	3, 173	281, 211	599	1, 226	4, 422	991
Montana.....		32					
Nebraska.....	276	1, 138					14
New Hampshire.....	7	40, 057	21, 663	42	123	50	
New Jersey.....	6, 980	117, 372	1, 083, 169	10, 053	489, 414	24, 837	40, 524
New Mexico.....			5, 000		84		
New York.....	4, 580	2, 641, 561	5, 479, 752	34, 839	13, 030, 797	33, 200	221, 040
North Carolina.....	82	769, 375	3, 728, 496		1, 290, 305	556	
North Dakota.....		26, 115					7
Ohio.....	2, 155	485, 564	46, 872	20, 589	72	484	129, 278
Oklahoma.....		510	14, 000				
Oregon.....	1, 584	72, 965	1, 065, 957	1, 409	1, 949, 659		2, 674
Pennsylvania.....	1, 571	390, 168	211, 993	2, 967	3, 029, 282	14, 241	52, 809
Rhode Island.....	1, 078	980	257, 965	1, 557	226, 800	157	5, 209

TABLE 36.—*Distribution of special-permit material by States for fiscal years 1920-1930—Continued*

State or Territory	Dahlia	Gladiolus	Iris, bulbous	Iris, rhizom- atous	Narcissus	Orchid	Peony
South Carolina.....			252, 500		8, 889, 490		
South Dakota.....		1, 701		11			2, 432
Tennessee.....	623		193, 896	595	833, 893		232
Texas.....	1	2, 000	745, 671	50	7, 741, 063	6	
Utah.....		126	30, 750		11, 400		
Vermont.....		14, 462	8, 010	36			2, 359
Virginia.....	313	20, 435	2, 409, 304	3	5, 307, 850	45	1, 682
Washington.....	1, 023	145, 653	1, 762, 088	3, 533	10, 152, 035	240	3, 615
West Virginia.....		230	4, 000				
Wisconsin.....	266	55, 843	107, 966	543	269, 250	1, 014	3, 918
Total.....	36, 484	28, 534, 307	32, 799, 646	139, 699	69, 531, 375	150, 347	674, 289

State or Territory	Rose	Fruit ¹	Herba- ceous ¹	Miscel- laneous bulbs, roots, etc. ¹	Orna- mental	Total
Alabama.....	174		110	35	273	52, 687
Arizona.....	9		51		4, 342	5, 442
Arkansas.....	50					18, 050
California.....	39, 860	232	1, 501	90, 330	2, 084, 372	20, 532, 756
Colorado.....			100		5, 787	72, 979
Connecticut.....	31, 508		1, 738	436	151, 407	259, 192
Delaware.....			17	38	5, 310	179, 344
District of Columbia.....	320				318	2, 024
Florida.....	21		50	85, 081	278, 210	7, 632, 762
Georgia.....		2		80	3, 075	196, 089
Idaho.....				180		3, 600
Illinois.....	10, 109	1	2	4, 052	227, 389	4, 672, 093
Indiana.....	2, 526		359	7, 088	30, 158	2, 945, 062
Iowa.....		375		180	14, 295	161, 354
Kansas.....	60			133	475	6, 262
Kentucky.....			92		3	52, 688
Louisiana.....	156		6	65	439	36, 727
Maine.....			56	287	917	1, 915
Maryland.....	575	6			75, 472	1, 690, 151
Massachusetts.....	3, 066		1, 331	2, 856	437, 009	4, 535, 580
Michigan.....	335		11, 516	15, 478	573, 180	16, 475, 201
Minnesota.....	160			11	35, 621	145, 316
Mississippi.....				5	252	63, 866
Missouri.....			255	43	19, 756	311, 929
Montana.....					100	132
Nebraska.....					351	1, 779
New Hampshire.....			10	410	1, 356	63, 718
New Jersey.....	36, 818	1	15, 290	12, 785	2, 695, 098	4, 532, 341
New Mexico.....						5, 084
New York.....	20, 862	63	35, 895	222, 911	3, 024, 079	24, 749, 579
North Carolina.....				20, 500	751	5, 810, 065
North Dakota.....	1					26, 123
Ohio.....	4, 975	64	4, 793	2, 941	765, 349	1, 463, 136
Oklahoma.....					198	14, 708
Oregon.....	1, 831		393	61, 147	55, 027	3, 212, 646
Pennsylvania.....	7, 803		177	10, 825	254, 735	3, 976, 571
Porto Rico.....					13	13
Rhode Island.....	552				46, 228	540, 526
South Carolina.....					3	9, 141, 993
South Dakota.....	2, 737		12		667	7, 560
Tennessee.....	87				3, 442	1, 032, 768
Texas.....	340		8		76, 140	8, 565, 279
Utah.....					4, 747	47, 023
Vermont.....					2, 506	27, 373
Virginia.....	16			2, 136	44, 774	7, 786, 558
Washington.....	776		153	5, 316	160, 021	12, 234, 453
West Virginia.....					36	4, 266
Wisconsin.....	520		1, 126	91	49, 957	490, 494
Total.....	166, 247	744	75, 041	545, 440	11, 133, 638	143, 787, 257

¹ Prior to 1929 this material was recorded under ornamentals, etc.

In addition to the foregoing, there was imported from Canada under regulation 15, quarantine No. 37, a total of 548,527 bulbs, plants, trees and cuttings, as compared with 691,475 during the fiscal year 1929.

To authorize the importation of this material 546 permits were issued in 1930, as compared with 542 in 1929.

IMPORTATIONS OF COTTON, COTTON WRAPPINGS (BAGGING), COTTONSEED, AND COTTONSEED PRODUCTS

Tables 37 to 40, inclusive, indicate, respectively, the importations of cotton, cotton waste, cotton wrappings (bagging), cottonseed, seed cotton, and cottonseed products during the year. The actual number of bales of cotton, cotton waste, and bagging is indicated, and inasmuch as bales vary in size they are referred to as "running" bales.

TABLE 37.—*Importation of running bales of ginned cotton, by country of growth and port of entry, fiscal year 1930*

Country	Boston	Buf- falo	Calex- ico	Charles- ton	De- troit	El Paso	Fabens	Gal- ves- ton	Hous- ton	Island Pond	Ma- lone	New Or- leans
Anglo-Egyptian Sudan..	36											
Brazil.....	10											
China.....	1,159											
Dutch East Indies.....	300											
Egypt.....	129,613											
India.....	18,841											
Irak.....	5											
Mexico.....			50,446			731	213					
Nigeria.....	221											
Peru.....	519											
United States (returned).....	1,354	273		3	38			602	199	8	25	504
Total.....	152,058	273	50,446	3	38	731	213	602	199	8	25	504

Country	New- port	New York	Ni- agara Falls	Ny- ando	Port- land	Rouses Point	Saint Al- bans	San Fran- cisco	San Pedro	Se- attle	Vance- boro	Total
Anglo-Egyptain Su- dan.....		1,836										1,872
Argentina.....		7										7
Brazil.....												10
British West Indies.....		613										613
China.....		2,833						31,876	99	8,006		43,973
Dutch East Indies.....		83			26			855				1,264
Egypt.....		28,936										158,549
Haiti.....		5										5
India.....		50,203			275			2,482	2,240	100		74,141
Irak.....												5
Mexico.....		2,555						52	125			54,122
Nigeria.....												221
Peru.....		22,789										23,308
Porto Rico.....		1,015										1,015
United States (re- turned).....	1,375	6,084	607	215		177	666				1,099	13,229
Total.....	1,375	116,959	607	215	301	177	666	35,265	2,464	8,106	1,099	1372,334

¹ Includes 12,435 bales of linters.

TABLE 38.—*Importation of running bales of cotton waste, by country of origin and port of entry, fiscal year 1930*

Country	Balti- more	Boston	Buf- falo	Charles- ton	De- troit	El Paso	Gal- ves- ton	Hous- ton	Jack- son- ville	New Or- leans	New- port	New York
Austria.....				71								985
Belgium.....	62	319					137	80				4,447
Canada.....		339	52		23						96	
China.....		25										150
England.....		2,801		168			43	50	179	77		2,850
France.....	93	499					47					4,311
Germany.....	1	5					50	354		2		5,501
Holland.....		952						167				5,695
India.....		25										8,064
Italy.....		20					69					1,401
Japan.....										100		1,085
Mexico.....						104						356
Scotland.....												52
Spain.....												1,246
Switzerland.....	10	95						94				1,049
United States (returned).....			50		75						31	22
Total.....	166	5,080	102	239	98	104	346	745	179	179	127	37,214

Country	Ni- agara Falls	Nor- folk	Phil- adel- phia	Port- land	Rich- ford	Saint Al- bans	San Fran- cisco	San Pedro	Sav- annah	Seattle	Total
Austria.....			100								1,156
Belgium.....			285						41		5,371
Canada.....	15				23	354					902
China.....			50	100			817	15		133	1,290
England.....		40	509	257					243		7,217
France.....			992								5,942
Germany.....			499								6,412
Holland.....			358				400				7,572
India.....			2,082					250			10,421
Italy.....			271								1,761
Japan.....			1,613	350			2,492	515		1,735	7,890
Mexico.....											460
Scotland.....											52
Spain.....											1,246
Switzerland.....			222				400				1,870
United States (returned).....						67					245
Total.....	15	40	6,981	707	23	421	4,109	780	284	1,868	59,807

TABLE 39.—*Importation of running bales of bagging, by country of origin and port of entry, fiscal year 1930*

Country	Balti- more	Bos- ton	Buf- falo	Charles- ton	Chi- cago	De- troit	Gal- veston	Hous- ton	New Orleans	New- port	New York
Algeria.....											791
Argentina.....											1,496
Austria.....									354		280
Belgium.....	6,191	641		1,316			247	15	1,798		5,171
Canada.....		611	69		67	4,168		120		114	1,246
China.....								390			
Cuba.....	23								1,050		
Denmark.....											446
Egypt.....		100									413
England.....	1,624	1,124		1,539			1,043	4,169	659		3,063
France.....	466	801		1,008			352	3,901	849		5,060
Germany.....	2,781	84					1,222	1,242	2,996		7,472
Greece.....											106
Holland.....	2,342	3,516		1,022			2,667	59	3,684		7,472
Italy.....	428	132					2,222	1,643	1,245		7,932
Japan.....		100					220	320	2,450		
Porto Rico.....											579
Russia.....											232
Scotland.....	560								251		3,227
Spain.....				1,464							6,597
Sweden.....											56
Turkey.....											241
United States (re- turned).....											8
Total.....	14,415	7,109	69	6,349	67	4,168	7,973	11,859	15,336	114	51,888

TABLE 39.—*Importation of running bales of bagging, by country of origin and port of entry, fiscal year 1930—Continued.*

Country	Ni- agara Falls	Nor- folk	Phila- delphia	Port Huron	San Fran- cisco	San Pedro	Sault Ste. Marie	Savan- nah	Seattle	Total
Algeria.....										791
Argentina.....			95							1,591
Austria.....		466	1,359							2,459
Belgium.....		4,241	3,264					820		23,704
Canada.....	104	263	1,425	4,043			631			12,861
China.....					1,908					2,298
Cuba.....										1,073
Denmark.....										446
Egypt.....										513
England.....		9,326	7,204					5,536		35,287
France.....		2,208	7,754					1,371		23,770
Germany.....		4,121	6,445					288		26,651
Greece.....			78							184
Holland.....		7,847	7,003					1,286		36,898
Italy.....		245	660							14,507
Japan.....					2,399	328			3,055	8,872
Lithuania.....			102							102
Porto Rico.....		172								751
Russia.....		946	528							1,706
Scotland.....		79	668							4,785
Spain.....			254							8,315
Sweden.....										56
Switzerland.....								231		231
Turkey.....										241
United States (returned).....										8
Unknown.....			2							2
Total.....	104	29,914	36,841	4,043	4,307	328	631	9,532	3,055	208,102

TABLE 40.—*Importation of cottonseed, seed cotton, and cottonseed products, fiscal year 1930*

Port	Cotton- seed	Seed cotton	Cottonseed hulls	Cottonseed cake	Cottonseed meal	Cotton- seed oil
	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Pounds</i>	<i>Gallons</i>
Boston.....				12,000	289,000	
Brownsville.....				2,944,900		
Buffalo.....			¹ 10,000			
Calxico.....	² 74,320		13,679,352			
Detroit.....					22	
El Paso.....				165,000	1,251,000	
Fabens.....					1,139,236	
Nogales.....						5
Portland.....					50,000	
San Francisco.....				105,600		
Yuma.....		² 486,710				
Total.....	74,320	486,710	13,689,352	3,227,500	2,729,258	5

¹ United States, returned.² Entry of cottonseed, seed cotton, and cottonseed hulls grown in the Imperial Valley, Lower California, Mexico, is allowed under permit.

In addition to the importations indicated in Tables 37-40, the administration supervised the entry of 726 packages of cotton samples imported by freight or express, 47 packages of cotton-waste samples imported by freight or express, and 16,029 packages of samples of cotton, cotton waste, and linters imported by parcel post.

IMPORTATIONS OF BROOMS, BROOMCORN, AND GRAIN

Tables 41 and 42 indicate, respectively, importations under quarantine No. 41 of brooms and clean shelled corn. Practically all the clean shelled corn (Table 42) was shipped from Argentina. This

quantity is 88,780 bushels less than the quantity imported last year, and represents a progressive decrease in such importations since the fiscal year 1928, the first year clean shelled corn from countries other than those covered by quarantine No. 24 was placed under restriction by quarantine No. 41. A marked decrease in importations of broomcorn has been noted since the fiscal year 1927. This is the second successive year in which no foreign broomcorn was imported. Seeds, other than corn, covered by quarantine No. 41 were imported as follows: Sorghum, 25 pounds; Jobs-tears, 1,385 pounds.

TABLE 41.—*Importation of brooms under quarantine No. 41, by country of origin and port of entry, fiscal year 1930*

Country	Laredo	New York	Total
Germany.....		720	720
Italy.....		688	688
Mexico.....	660		660
Rumania.....		19,000	19,000
Total.....	660	20,408	21,068

TABLE 42.—*Importation, in bushels, of clean shelled corn under quarantine No. 41, by port of entry and country of growth, fiscal year 1930*

Port	Argentina	Bahama Islands	Canada	Mexico	Union of South Africa	United States (returned)	Total
Baltimore.....	18,800						18,800
Boston.....	3,921						3,921
Detroit.....			3			197	200
Miami.....		28					28
New Orleans.....	945						945
New York.....	87,067				73		87,140
Niagara Falls.....						13	13
Nogales.....				7			7
Philadelphia.....	34,472						34,472
Seattle.....	2,000						2,000
Total.....	147,205	28	3	7	73	210	147,526

In addition, the administration supervised the entry under quarantine No. 24 at San Francisco of 17,854 bushels of clean shelled corn from Manchuria, and, under quarantine No. 55, of 4,180,598 pounds of seed or paddy rice from Mexico.

IMPORTATIONS OF FRUITS AND VEGETABLES

Tables 43 and 44 indicate the fruits and vegetables imported under permit and subject to inspection at the port of first arrival under the provisions of quarantine No. 56 during the fiscal year; Table 43 by countries of origin, and Table 44 by ports of entry.

TABLE 43.—*Fruits and vegetables imported fiscal year 1930, by countries of origin*

[Imported under quarantine No. 56 unless otherwise designated]

Kind	Country and quantity	Total
Apple.....pounds..	Belgium, 20; Chile, 15,736; Germany, 223; Netherlands, 15..	15,994
Apricot.....do.....	Chile, 14,910..	14,910
Arrowroot.....do.....	Japan, 1,001..	1,001
Asparagus.....do.....	Argentina, 21,825; Chile, 140; Mexico, 6,669..	28,634
Avocado.....do.....	Cuba, 6,597,833; Dominica, British West Indies, 2,990; Dominican Republic, 210; Jamaica, 12,322; Mexico (seeds removed) 126,967; St. Lucia, British West Indies, 3,400; St. Vincent, British West Indies, 60..	6,743,788
Baked-apple berry.....do.....	Newfoundland, 80..	80
Balsam pear.....do.....	Cuba, 10,007..	10,007
Banana.....bunches..	Brazil, 1,000; British Guiana, 20; Colombia, 1,267,122; Costa Rica, 3,506,110; Cuba, 3,951,133; Dominican Republic, 57; Ecuador, 12; Grenada, British West Indies, 12; Guadeloupe, French West Indies, 406; Guatemala, 5,694,006; Haiti, 1,344; Honduras, 23,451,580; British Honduras, 125,292; Jamaica, British West Indies, 11,547,411; Martinique, French West Indies, 108; Mexico, 6,084,716; Nicaragua, 4,297,768; Panama (including Canal Zone), 4,573,445..	64,501,542
Bean (green):		
Faba.....pounds..	Mexico, 67,321..	67,321
Lima.....do.....	Cuba, 2,998,644; Mexico, 269,627..	3,268,271
String.....do.....	Cuba, 127,530; Mexico, 3,295,142..	3,422,672
Beet.....do.....	Bermuda, 3,870; Denmark, 320,376; Germany, 99,870; Italy, 492; Mexico, 360,636; Netherlands, 14,960..	800,204
Berry (Rubus).....do.....	Newfoundland, 25,000; Norway, 1,100..	26,100
Burdock.....do.....	Japan, 6,400..	6,400
Cabbage.....do.....	Cuba, 360,457; Denmark, 5,006,660; Germany, 1,888,638; Mexico, 81,410; Netherlands, 34,847,112..	42,184,277
Cacao bean pod.....do.....	Costa Rica, 570..	570
Carrot.....do.....	Belgium, 46,300; Bermuda, 96,838; Mexico, 618,799; Netherlands, 1,865,485..	2,627,432
Cassava.....do.....	China, 900; Cuba, 285,756; Dominican Republic, 2,350..	289,006
Cauliflower.....do.....	Belgium, 280; Mexico, 3,057; Netherlands, 200..	3,537
Celery.....do.....	Bermuda, 2,599,333; Mexico, 2,806..	2,602,139
Chayote.....do.....	Cuba, 93,738; Dominican Republic, 12,748; Jamaica, British West Indies, 40; Mexico, 3,035..	109,561
Cherry:		
Dried, sour.....do.....	Italy, 856,768; Rumania, 21,000; Yugoslavia, 634,224..	1,511,992
Fresh.....do.....	Chile, 100..	100
Chervil.....do.....	Bermuda, 400..	400
Chinese watermelon.....do.....	Cuba, 7,443..	7,443
Cipollino.....do.....	Italy, 129,057; Morocco (French) 3,078,991..	3,208,048
Citrus medica.....do.....	Albania, 1,150; Greece, 156; Italy, 1,278; Palestine, 20,776..	23,360
Clover top.....do.....	Mexico, 1,423..	1,423
Crescentia alata.....do.....	Mexico, 100..	100
Crosnes.....do.....	Belgium, 2,070..	2,070
Cucumber.....do.....	Bahamas, 4,720; Belgium, 60; Cuba, 1,702,407; Mexico, 126,487; Netherlands, 243..	1,833,917
Dasheen (includes colocasia, caladium, inhame, malanga, and taro), pounds.	Azores, 488,663; China, 761,449; Cuba, 317,052; Dominican Republic, 1,018,045; Japan, 242,203; Madeira Islands, 400; Mexico, 27,089..	2,854,899
Eggplant.....do.....	Cuba, 6,458,260; Mexico, 1,054,091; Virgin Islands, 14,750..	7,507,101
Endive.....do.....	Belgium, 1,976,016; England, 9,830; Mexico, 208..	1,986,054
Fennel.....do.....	Bermuda, 754..	754
Garbanzo.....do.....	Mexico, 500..	500
Garlic.....do.....	Azores, 160; Chile, 800,127; China, 90; Egypt, 15,350; Germany, 64,449; Hungary, 22,046; Italy, 185,399; Mexico, 1,501,117; Spain, 3,638..	2,592,376
Ginger (crude).....do.....	China, 421,504; Cuba, 23,258; Dominican Republic, 2,206; Jamaica, British West Indies, 68; Japan, 1,404; St. Lucia, British West Indies, 100..	448,540
Grape:		
Fresh (not hothouse).....do.....	Argentina, 7,089,378; Chile, 84,998; Mexico, 818..	7,175,194
Hothouse.....do.....	Belgium, 280,717; Bulgaria, 30; England, 450; Netherlands, 280..	281,477
Grapefruit.....pounds..	Cuba, 9,826,970; Jamaica, British West Indies, 64,890..	9,891,860
Horseradish.....do.....	Germany, 2,822,248; Netherlands, 2; Rumania, 6,980; Russia, 2,153; Sweden, 22,015..	2,853,398
Husk tomato.....do.....	Mexico, 82,152..	82,152
Jicama.....do.....	Mexico, 12,902..	12,902
Kale.....do.....	Bermuda, 271,005; Mexico, 923..	271,928
Kohlrabi.....do.....	Mexico, 238..	238
Kudzu.....do.....	China, 126,327; Japan, 463..	126,790
Lemon.....crates.....	Chile, 12; Cuba, 62; Italy, 1,115,251; Sicily, 5; Spain, 318..	1,115,648
Lettuce.....pounds..	Bermuda, 160; Mexico, 89,877..	90,037
Lily bulb (edible).....do.....	China, 34,539..	34,539
Lime (sour).....do.....	Antigua, British West Indies, 16,600; Costa Rica, 11,562; Cuba, 697; Dominica, British West Indies, 3,171,620; Dominican Republic, 87,980; Honduras, 140; Jamaica, British West Indies, 637,476; Mexico, 2,865,228; St. Lucia, British West Indies, 121,114; St. Vincent, British West Indies, 3,140; Trinidad British West Indies, 2,850..	6,918,407

TABLE 43.—*Fruits and vegetables imported fiscal year 1930, by countries of origin—Continued*

[Imported under quarantine No. 56 unless otherwise designated]

Kind	Country and quantity	Total
Melon.....do.....	Argentina, 59,979; Chile, 3,264,605; Cuba, 2,830; Italy, 440; Mexico, 1,442,138; Portugal, 2,730; Spain, 416,363; Uruguay, 1,323.	5, 190, 408
Mint.....do.....	Bermuda, 4,265; Mexico, 925	5, 190
Mustard.....do.....	Bermuda, 620; Mexico, 83,475	84, 095
Nectarine.....do.....	Belgium, 255; Chile, 164,820	165, 075
Nuts (in the shell):		
Acorn.....do.....	Greece, 3,365,206; Mexico, 1,920; Turkey, 21,893,565	25, 260, 691
Chestnut.....do.....	China, 25,005; Italy, 15,853,785; Japan, 412,672; Netherlands, 250; Portugal, 26,785; Spain, 128,635.	16, 447, 132
Okra.....do.....	Cuba, 1,625,908; Mexico, 180	1, 626, 088
Onion.....do.....	Australia, 101,440; Azores, 14,944; Bermuda, 6,324; Chile, 2,946,157; China 67; Cuba, 29,875; Egypt, 1,744,536; England, 48,400; Italy, 1,957,033; Madeira Islands, 5; Mexico, 374,100; Netherlands, 150,620; Spain, 48,407,674; Virgin Islands, 64,262	55, 845, 437
Orange:		
Under quarantine No. 56, pounds.	Chile, 28,500; Cuba, 668,741; Jamaica, British West Indies, 60,770.	758, 011
Mandarin (quarantine No. 28), pounds.	Japan, 2,081,970	2, 081, 970
Pachyrhizus.....pounds.....	China, 48,200	48, 200
Parsley.....do.....	Bermuda, 580,251; Cuba, 260; Mexico, 30,428	610, 939
Parsnip.....do.....	Mexico, 1,720; Netherlands, 19,980	21, 700
Pea.....do.....	Cuba, 60; Mexico, 30,104,541	30, 104, 601
Peach.....do.....	Argentina, 3,553; Belgium, 289; Chile, 176,385	180, 227
Pear.....do.....	Belgium, 18	18
Pepper.....do.....	Bahamas, 5,240; Cuba, 5,077,751; Dominican Republic, 695; Haiti, 48; Mexico, 9,158,096; Virgin Islands, 7,820.	14, 249, 650
Pigeon pea.....do.....	Dominican Republic, 40	40
Pigweed.....do.....	Mexico, 1,676	1, 676
Pineapple.....crates.....	Azores, 25; Brazil, 57; Costa Rica, 775; Cuba, 1,391,843; Dominican Republic, 31; Haiti, 2,382; Honduras, 1,153; Mexico, 1,799; Nicaragua, 6.	1, 398, 071
Plantain.....bunches.....	Cuba, 441,916; Dominican Republic, 9,333; Honduras, 60,637; British Honduras, 2,959; Panama, 33,596.	548, 441
Plum.....pounds.....	Argentina, 2,000; Chile, 44,875	46, 875
Potato:		
Under quarantine No. 56, pounds.	Bermuda, 3,801,338	3, 801, 338
Under potato regulations (order of Dec. 22, 1913), pounds.	Cuba, 4,791,936; Estonia, 7,345,730, Mexico, 523,598	12, 661, 264
Pricklypear.....pounds.....	Mexico, 4,705	4, 705
Pumpkin.....do.....	Cuba, 36,764; Dominican Republic, 131,010; Mexico, 15,984; Syria, 58.	183, 816
Purslane.....do.....	Mexico, 1,547	1, 547
Quince.....do.....	Argentina, 475	475
Radish.....do.....	Bermuda, 160; Cuba, 580; Mexico, 107,189	107, 929
Rhubarb.....do.....	Mexico, 13	13
Sea-onion.....do.....	Denmark, 1,800	1, 800
Shallot.....do.....	France, 159	159
Sorrel.....do.....	Bermuda, 1,688	1, 688
Spinach.....do.....	Bermuda, 600; Mexico, 151,083	151, 683
Squash.....do.....	Cuba, 439,071; Mexico, 337,612	776, 683
Strawberry.....do.....	Cuba, 50; Mexico, 132	182
Swiss chard.....do.....	Italy, 207; Mexico, 8,346	8, 553
Tamarind bean pod.....do.....	Antigua, British West Indies, 77,042; Cuba, 4,625; Dominican Republic, 10; Italy, 1,063; Mexico, 874; Nevis, British West Indies, 27,330; St. Kitts, British West Indies, 37,981.	148, 925
Tangerine.....do.....	Cuba, 3	3
Tarragon.....do.....	Bermuda, 200	200
Tomato.....do.....	Bahamas, 3,642,582; Belgium, 660; Bermuda, 1,350; Canary Islands, 500; Chile, 1,800; Cuba, 19,079,331; England, 1,200; Guernsey, Channel Islands, 5,064; Haiti, 312; Mexico, 119,294,354; Virgin Islands, 5,400.	142, 032, 553
Turnip.....do.....	Bermuda, 6,260; Cuba, 841; Mexico, 367,712	374, 813
Vaccinium (cranberry, etc.), pounds.	Finland, 3,904; Newfoundland, 3,552,206; Sweden, 100	3, 556, 210
Waterchestnut.....pounds.....	China, 1,876,482; Japan, 4,515	1, 880, 997
Water cress.....do.....	Mexico, 5,967	5, 967
Waterlily root.....do.....	China, 23,649; Cuba, 46,914; Japan, 400	70, 963
Watermelon.....do.....	Cuba, 50,340; Mexico, 336,306	386, 646

TABLE 44.—*Fruits and vegetables imported fiscal year 1930, by ports of entry*

[Imported under quarantine No. 56 unless otherwise designated]

Kind	Port and quantity	Total
Apple.....pounds..	New York, 15,994.....	15,994
Apricot.....do.....	New York, 14,910.....	14,910
Arrowroot.....do.....	Seattle, 1,001.....	1,001
Asparagus.....do.....	New York, 21,965; Nogales, 1; San Ysidro, 6,668.....	28,634
Avocado.....do.....	Boston, 790; Brownsville (seeds removed), 1,426; Eagle Pass (seeds removed), 7,790; El Paso (seeds removed), 23,897; Hidalgo (seeds removed), 13,075; Key West, 1,037,760; Laredo (seeds removed), 79,327; New Orleans, 1,896,215; New York, 1,854,637; Nogales, 1,452; Tampa, 1,827,419.	6,743,788
Baked-apple berry.....do.....	New York, 80.....	80
Balsam pear.....do.....	New York, 10,007.....	10,007
Banana.....bunches..	Baltimore, 3,370,686; Boston, 3,370,465; Brownsville, 16,046; Cannons Corners, 86; Charleston, 891,001; Detroit, 53,849; Eagle Pass, 1,819; Eastport, Me., 57; El Paso, 1,379,168; Galveston, 1,865,876; Houlton, Me., 480; Key West, 5,993; Laredo, 118,737; Los Angeles, 1,653,869; Miami, 213,172; Mobile, 2,716,237; New Orleans, 21,091,042; New York, 19,769,253; Nogales, 35,923; Philadelphia, 5,424,231; Port Huron, 2,170; San Francisco, 1,760,348; Sault Ste. Marie, 3,342; Tampa, 757,692.	64,501,542
Bean (green):		
Faba.....pounds..	Nogales, 67,321.....	67,321
Lima.....do.....	Laredo, 73,860; New York, 2,998,644; Nogales, 123,184; San Ysidro, 72,583.	3,268,271
String.....do.....	Brownsville, 417,696; Calexico, 412; Del Rio, 60; Douglas, 6,894; Eagle Pass, 5,176; El Paso, 314,795; Hidalgo, 140; Laredo, 1,439,466; Mercedes, 4,854; Naco, 1,813; New York, 127,530; Nogales, 478,200; San Ysidro, 625,636.	3,422,672
Beet.....do.....	Calexico, 283; Douglas, 21,305; Eagle Pass, 526; El Paso, 318,807; Naco, 2,859; New York, 439,568; Nogales, 16,696; Presidio, 160.	800,204
Berry (Rubus).....do.....	New York, 26,100.....	26,100
Burdock.....do.....	Los Angeles, 5,900; San Francisco, 500.....	6,400
Cabbage.....do.....	Boston, 1,132,558; Brownsville, 9,500; Calexico, 2,789; Douglas, 14,055; Eagle Pass, 469; El Paso, 2,620; Key West, 6,045; Laredo, 20,190; Naco, 2,349; New Orleans, 278,472; New York, 40,614,567; Nogales, 29,355; Philadelphia, 55,000; Presidio, 83; Tampa, 16,225.	42,184,277
Cacao bean pod.....do.....	New York, 570.....	570
Carrot.....do.....	Boston, 10,000; Calexico, 491; Douglas, 24,331; Eagle Pass, 684; El Paso, 560,036; Laredo, 66; Naco, 4,398; New York, 1,998,633; Nogales, 28,548; Presidio, 245.	2,627,432
Cassava.....do.....	Chicago, 900; Key West, 26,834; New York, 224,742; Tampa, 36,530.	289,006
Cauliflower.....do.....	Calexico, 5; Douglas, 400; El Paso, 120; Laredo, 409; Naco, 90; New York, 480; Nogales, 2,033.	3,537
Celery.....do.....	Calexico, 13; Douglas, 2,549; New York, 2,599,333; Nogales, 244.	2,602,139
Chayote.....do.....	Boston, 40; El Paso, 1,624; Key West, 2,230; Laredo, 1,370; New Orleans, 32,665; New York, 70,487; Nogales, 21; Tampa, 1,124.	109,561
Cherry:		
Dried sour.....do.....	Baltimore, 11,023; Boston, 312,626; New York, 920,309; Philadelphia, 268,034.	1,511,992
Fresh.....do.....	New York, 100.....	100
Chervil.....do.....	New York, 400.....	400
Chinese watermelon.....do.....	New York, 7,443.....	7,443
Cipollino.....do.....	Boston, 14,534; New York, 3,193,514.....	3,208,048
Citrus medica.....do.....	Detroit, 2,072; El Paso, 12; New York, 21,132; Portland, 144.	23,360
Clover top.....do.....	Douglas, 1,296; Naco, 127.....	1,423
Crescentia alata.....do.....	Nogales, 100.....	100
Crosnes.....do.....	New York, 2,070.....	2,070
Cucumber.....do.....	Brownsville, 8,296; Calexico, 662; Douglas, 3,392; Eagle Pass, 1,890; El Paso, 185; Key West, 876; Laredo, 1,727; Miami, 3,640; Naco, 999; New Orleans, 52,793; New York, 1,647,258; Nogales, 109,336; Tampa, 2,863.	1,833,917
Dasheen (includes colocasia, caladium, inhame, malanga, and taro).....pounds..	Boston, 26,473; Calexico, 27,080; Chicago, 2,100; Key West, 27,478; Los Angeles, 52,750; New Orleans, 2,360; New York, 1,353,918; Nogales, 9; Philadelphia, 13,698; Portland, 1,775; Providence, 489,063; San Francisco, 612,835; Seattle, 182,649; Tampa, 62,711.	2,854,899
Eggplant.....pounds..	Calexico, 1,588; Douglas, 1,591; Eagle Pass, 60; El Paso, 2,025; Key West, 248,990; Laredo, 4,373; Los Angeles, 40,920; Naco, 67; New Orleans, 1,428,265; New York, 4,764,485; Nogales, 1,003,387; San Ysidro, 80; Tampa, 11,270.	7,507,101
Endive.....do.....	New York, 1,985,846; Nogales, 8; San Ysidro, 200.....	1,986,054
Fennel.....do.....	New York, 754.....	754
Garbanzo.....do.....	Brownsville, 500.....	500
Garlic.....do.....	Brownsville, 6,816; Calexico, 17,787; Douglas, 4,094; Eagle Pass, 5,915; El Paso, 33,358; Hidalgo, 532; Laredo, 851,710; Naco, 428; New Orleans, 31,270; New York, 1,628,880; Nogales, 11,426; Providence, 160.	2,592,376

TABLE 44.—*Fruits and vegetables imported fiscal year 1930, by ports of entry—Con.*

Kind	Port and quantity	Total
Ginger (crude).....pounds..	Boston, 13,235; Chicago, 1,600; Los Angeles, 8,100; New Orleans, 1,622; New York, 112,008; Portland, 1,000; San Francisco, 282,864; Seattle, 28,111.	448, 540
Grape:		
Fresh(not hothouse).do....	Baltimore, 49,908; Calexico, 20; Eagle Pass, 575; Laredo, 80; New York, 7,124,468; Nogales, 143.	7, 175, 194
Hothouse.....do.....	New York, 281,477	281, 477
Grapefruit.....do.....	Baltimore, 481; Boston, 11,340; Chicago, 1,687,684; Cincinnati, 686,070; New York, 5,450,815; St. Louis, 2,055,470.	9, 891, 860
Horseradish.....do.....	New York, 2,830,709; Philadelphia, 22,689	2, 853, 398
Husk tomato.....do.....	Brownsville, 8,665; El Paso, 72,242; Hidalgo, 1,245	82, 152
Jicama.....do.....	El Paso, 12,902	12, 902
Kale.....do.....	El Paso, 110; New York, 271,005; Nogales, 813	271, 928
Kohlrabi.....do.....	Calexico, 6; El Paso, 115; Nogales, 117	238
Kudzu.....do.....	Boston, 5,598; Los Angeles, 6,300; New York, 36,100; Portland, 400; San Francisco, 62,680; Seattle, 15,712.	126, 790
Lemon.....crates.....	Boston, 1,212; Detroit, 475; New Orleans, 101,377; New York, 1,011,916; Philadelphia, 563; Port Huron, 5; Tampa, 100.	1, 115, 648
Lettuce.....pounds.....	Calexico, 47; Douglas, 25,313; Eagle Pass, 1,383; El Paso, 13,545; Naco, 5,986; New York, 160; Nogales, 28,876; Presidio, 612; San Ysidro, 14,115.	90, 037
Lily bulb (edible).....do.....	Boston, 5,592; Los Angeles, 100; New Orleans, 200; New York, 13,938; San Francisco, 10,761; Seattle, 3,948.	34, 539
Lime (sour).....do.....	Baltimore, 452; Boston, 6,363; Brownsville, 8,315; Eagle Pass, 194,401; El Paso, 171,227; Galveston, 15,382; Hidalgo, 210; Houston, 12,375; Laredo, 2,194,959; Los Angeles, 266,310; New Orleans, 257,654; New York, 3,755,680; Nogales, 3,354; Norfolk, 18,750; Philadelphia, 1,000; Presidio, 145; San Francisco, 11,830.	6, 918, 407
Melon.....do.....	Boston, 7,920; Calexico, 683; Douglas, 423; Eagle Pass, 30; El Paso, 20; Key West, 2,830; Laredo, 620; Naco, 586; New York, 3,734,790; Nogales, 1,439,776; Providence, 2,730.	5, 190, 408
Mint.....do.....	Calexico, 27; Douglas, 31; Eagle Pass, 35; El Paso, 831; New York, 4,265; Nogales, 1.	5, 190
Mustard.....do.....	Calexico, 8,125; Douglas, 17,002; El Paso, 50,295; New York, 620; Nogales, 8,053.	84, 095
Nectarine.....do.....	New York, 165,075	165, 07
Nuts (in the shell):		
Acorn.....do.....	Baltimore, 200,860; Naco, 1,920; New York, 24,001,151; Norfolk, 243,450; Philadelphia, 813,310.	25, 260, 691
Chestnut.....do.....	Los Angeles, 132,250; New Orleans, 250; New York, 15,951,025; San Francisco, 292,757; Seattle, 70,850.	16, 447, 132
Okra.....do.....	El Paso, 140; Key West, 19,740; New Orleans, 886,750; New York, 607,258; Nogales, 40; Tampa, 112,160.	1, 626, 088
Onion.....do.....	Boston, 2,159,816; Brownsville, 804; Calexico, 1,194; Douglas, 61,358; Eagle Pass, 4,345; El Paso, 253,991; Laredo, 16,990; Naco, 6,696; New Orleans, 4,725; New York, 53,105,213; Nogales, 28,222; Philadelphia, 85,122; Presidio, 500; Providence, 14,949; San Francisco, 27,627; Seattle, 73,880; Washington, D. C., 5.	55, 845, 437
Orange:		
Under quarantine No. 56.....pounds.....	Baltimore, 984; Boston, 18,340; Chicago, 145,182; Cincinnati, 24,000; New York, 569,505.	758, 011
Mandarin (quarantine No. 28).....pounds.....	Seattle, 2,081,970	2, 081, 970
Pachyrhizus.....do.....	Los Angeles, 11,700; San Francisco, 36,500	48, 200
Parsley.....do.....	Calexico, 2; Douglas, 2,302; Eagle Pass, 23; El Paso, 27,739; Naco, 182; New York, 580,511; Nogales, 180.	610, 939
Parsnip.....do.....	El Paso, 1,720; New York, 19,980	21, 700
Pea.....do.....	Calexico, 424; Douglas, 1,600; Eagle Pass, 1,355; El Paso, 1,113; Laredo, 22,507; Naco, 1,062; New York, 60; Nogales, 30,050,895; Presidio, 170; San Ysidro, 25,415.	30, 104, 601
Peach.....do.....	New York, 180,227	180, 227
Pear.....do.....	New York, 18	18
Pepper.....do.....	Brownsville, 33,754; Calexico, 326; Del Rio, 22,392; Douglas, 26,439; Eagle Pass, 188,312; El Paso, 693,628; Hidalgo, 7,050; Key West, 81,975; Laredo, 657,510; Los Angeles, 28,405; Miami, 240; Naco, 2,762; New Orleans, 1,172,298; New York, 3,833,228; Nogales, 7,407,488; Presidio, 183; San Ysidro, 89,847; Tampa, 3,813.	14, 249, 650
Pigeon pea.....pounds.....	New York, 40	40
Pigweed.....do.....	Douglas, 1,203; Naco, 350; Nogales, 123	1, 676
Pineapple.....crates.....	Brownsville, 133; Eagle Pass 4; El Paso, 1,347; Hidalgo, 1; Key West, 999,987; Laredo, 32; Miami, 103; Mobile, 26; Naco, 6; New Orleans, 71,603; New York, 305,583; Nogales, 172; Providence, 25; San Francisco, 6; Tampa, 19,043.	1, 398, 071
Plantain.....bunches.....	Baltimore, 63,528; Boston, 780; Charleston, 615; Key West, 47,918; Miami, 31,010; Mobile, 3,344; New Orleans, 35,927; New York, 96,855; Philadelphia, 158,791; Tampa, 109,673.	548, 441
Plum.....pounds.....	New York, 46,875	46, 875

TABLE 44.—*Fruits and vegetables imported fiscal year 1930, by ports of entry—Con.*

Kind	Port and quantity	Total
Potato:		
Under quarantine No. 56, pounds.	New York, 3,801,338	3,801,338
Under potato regulations (order of Dec. 22, 1913), pounds.	Douglas, 198,908; Key West, 298,956; Naco, 19,540; New Orleans, 181,960; New York, 11,656,750; Nogales, 305,150.	12,661,264
Pricklypear.....pounds..	Calexico, 10; El Paso, 4,345; Laredo, 340; Nogales, 10	4,705
Pumpkin.....do.....	Brownsville, 220; Calexico, 111; Douglas, 2,141; Eagle Pass, 1,907; El Paso, 470; Japata, 30; Key West, 22,304; Laredo, 8,260; Naco, 50; New York, 140,060; Nogales, 2,795; Philadelphia, 600; Providence, 58; Tampa, 4,810.	183,816
Purslane.....do.....	Douglas, 493; El Paso, 20; Nogales, 1,034	1,547
Quince.....do.....	New York, 475	475
Radish.....do.....	Calexico, 462; Douglas, 6,880; Eagle Pass, 145; El Paso, 88,364; Naco, 1,530; New York, 740; Nogales, 9,713; Presidio, 95.	107,929
Rhubarb.....do.....	Calexico, 10; Nogales, 3	13
Sea-onion.....do.....	New York, 1,800	1,800
Shallot.....do.....	New York, 159	159
Sorrel.....do.....	New York, 1,688	1,688
Spinach.....do.....	Calexico, 186; Douglas, 27,745; Eagle Pass, 177; El Paso, 94,694; Naco, 2,898; New York, 600; Nogales, 25,383.	151,683
Squash.....do.....	Brownsville, 80; Calexico, 1,468; Douglas, 13,394; Eagle Pass, 370; El Paso, 120,182; Key West, 300; Laredo, 88,141; Naco, 1,432; New Orleans, 33,305; New York, 404,946; Nogales, 66,597; Presidio, 80; San Ysidro, 45,868; Tampa, 520.	776,683
Strawberry.....do.....	Calexico, 2; El Paso, 90; New York, 50; Nogales, 40	182
Swiss chard.....do.....	El Paso, 8,346; New York, 207	8,553
Tamarind bean pod.....do.....	Calexico, 30; El Paso, 44; Laredo, 800; New Orleans, 615; New York, 147,436.	148,925
Tangerine.....do.....	New York, 3	3
Tarragon.....do.....	New York, 200	200
Tomato.....do.....	Brownsville, 74,936; Calexico, 191; Del Rio, 7,810; Detroit, 203,924; Douglas, 25,334; Eagle Pass, 107,289; El Paso, 567,171; Hidalgo, 8,810; Jacksonville, 180; Key West, 3,578,168; Laredo, 1,016,682; Los Angeles, 6,125,315; Mercedes, 870; Miami, 375,600; Naco, 4,810; New Orleans, 1,466,840; New York, 17,335,335; Nogales, 108,354,015; Presidio, 264; San Diego, 49,230; San Francisco, 2,630,881; San Ysidro, 7,169; Tampa, 91,729.	142,032,553
Turnip.....do.....	Calexico, 173; Douglas, 20,788; El Paso, 330,036; Naco, 2,663; New York, 7,101; Nogales, 13,772; Presidio, 280.	374,813
Vaccinium (cranberry, etc.), pounds.	Boston, 1,404,788; New York, 2,151,422	3,556,210
Waterchestnut.....pounds..	Boston, 80,183; Chicago, 55,000; Los Angeles, 112,700; New York, 544,066; Portland, 5,200; San Francisco, 671,114; Seattle, 412,734.	1,880,997
Water cress.....do.....	Calexico, 16; Douglas, 3,717; Naco, 749; Nogales, 1,485	5,967
Waterlily root.....do.....	Boston, 1,500; Chicago, 500; New York, 46,914; Portland, 300; San Francisco, 13,000; Seattle, 8,749.	70,963
Watermelon.....do.....	Brownsville, 700; Calexico, 2,142; Douglas, 2,043; Eagle Pass, 8,250; El Paso, 12,649; Key West, 50,340; Laredo, 6,050; Naco, 480; Nogales, 301,492; Japata, 2,500.	386,646

As compared with the fruit and vegetable imports of the fiscal year 1929, some rather marked fluctuations are to be noted, although the aggregate net increase of the 1930 imports is only 6.4 per cent over the 1929 imports. For example, among the products showing an increase of more than 20 per cent during the fiscal year 1930 are the following: Acorns, 233 per cent; asparagus, 46 per cent; avocados, 42 per cent; beans (faba), 231 per cent; beets, 99 per cent; cabbage, 576 per cent; fresh grapes, 61 per cent; grapefruit, 95 per cent; horseradish, 105 per cent; lemons, 236 per cent; limes (sour), 23 per cent; oranges, exclusive of mandarins, 380 per cent; peas (fresh), 46.5 per cent; peaches, 2,961 per cent; tamarind bean pods, 232 per cent; cranberries, 23 per cent. An increase of 10 per cent in the importation of potatoes from Cuba and Mexico is shown, but from Bermuda there is a decrease of 31 per cent.

The following-named products show a decreased importation: Carrots, 53 per cent; endive, 23 per cent; garlic, 26 per cent; onions, 53 per cent.

PLANTS AND PLANT PRODUCTS ENTERED FOR IMMEDIATE EXPORTATION OR FOR IMMEDIATE TRANSPORTATION AND EXPORTATION IN BOND

In addition to the regulated imports for consumption entry recorded in the foregoing tables, the administration supervised the entry under permit, either for immediate exportation or for immediate transportation and exportation in bond, of considerable quantities of plants and plant products. Among the principal items may be mentioned approximately 1,249,900 bulbs, 159,200 convallaria pips, 498,000 fruit trees and roses, 28,800 cacti, 20,900 orchids, 13,570 miscellaneous plants, shrubs, and trees, 665,900 pounds of apples, 22,873,000 pounds of citrus fruits, 4,875,000 pounds of potatoes, 21,629,000 pounds of onions, 2,140,500 pounds of garlic, 13,527,000 pounds of tomatoes, 71,556 bales of cotton, 224 bales of cotton waste, 147 bales of bagging, 10,562 pounds of cottonseed, 602,000 pounds of cottonseed cake, 420,000 pounds of cottonseed meal, 48,896 gallons of cottonseed oil, and 232,990 bushels of clean shelled corn.

CERTIFICATION FOR EXPORT

In order to meet the inspection and certification requirements of various foreign countries as a condition for the entry of plants and plant products into those countries from the United States provisions are made for such required inspection and certification under the rules and regulations of the Secretary of Agriculture governing the inspection and certification of plants and plant products offered for export to meet the sanitary requirements of foreign countries. Such service is furnished on the payment of fees covering the cost of the inspection. A total of \$11,447.50 was collected in fees under the provisions of these regulations and covered into the Treasury of the United States as miscellaneous receipts.

NEW AND REVISED PLANT QUARANTINES AND MISCELLANEOUS REGULATIONS

The following quarantines and miscellaneous regulations have been either revised or lifted during the year.

DOMESTIC QUARANTINES

The Asiatic-beetle and Asiatic-garden-beetle quarantine regulations were amended January 8, 1930, by eliminating the screening requirement with respect to potted plants; and on February 20, 1930, effective March 1, 1930, the quarantine was lifted.

The European corn-borer quarantine regulations were revised December 16, 1929, by (1) adding 655 townships to the regulated area; (2) placing the limitation on the quantity of clean shelled corn which may be shipped without certification or other restriction at 25 pounds to the shipment instead of 2 pounds, as theretofore; (3) allowing free movement of green corn on the cob from New York City during the months of May and June, the period during which no such corn produced within the regulated area reaches that city;

and (4) removing the special restriction applying to Maine as to entry of the restricted articles from the regulated areas outside that State.

The Japanese-beetle quarantine regulations were amended January 8, 1930, by eliminating the screening requirement with respect to potted plants; the quarantine and regulations were revised February 21, 1930, by the inclusion of the State of Massachusetts under the quarantine, by extending the regulated area in Connecticut, New York, Pennsylvania, Maryland, Delaware, and Virginia, and by dividing the regulated area into generally infested and lightly infested areas. Restrictions on the interstate movement of farm products apply to such movement from the generally infested area but not from the lightly infested areas. Regulations governing the interstate shipment of nursery and ornamental stock, and of sand, soil, earth, peat, compost, and manure, apply from the generally infested area to the lightly infested areas as well as from either to points entirely outside the regulated areas.

The Mediterranean fruit-fly and melon-fly quarantine regulations of Hawaii were revised May 20, 1930, by adding lily and ginger roots to the products which may be shipped to the mainland under inspection and certification, and by making provision for inspection of baggage and cargo either on the docks or on the ship while in the quarantine area, at the discretion of the inspector.

The Mediterranean fruit-fly quarantine regulations were modified by administrative instructions on July 2, 1929, by authorizing the shipment of Florida grapes from cold-storage plants to the District of Columbia and points north and east; on July 23, 1929, by the removal of restrictions on destination of limes from Monroe and Dade Counties, Fla.; and on August 12, 1929, by the removal of restrictions on string beans; the quarantine and regulations were revised August 20, 1929, effective September 1, 1929, by adding cotton bolls and seed cotton to the list of restricted articles, making provision for movement of host fruits under sterilization, and designating an eradication area within which an intensive eradication program was prescribed; the revised regulations were modified and interpreted by administrative instructions on August 30, 1929, by authorizing the retention on the trees of early-ripening citrus fruit until reaching a marketable stage of ripeness, and by allowing the shipment of such fruit prior to October 1; on September 7, 1929, by making provision for diversion of Florida products at southern points; on September 16, 1929, by releasing portions of Brevard, Osceola, Polk, and Hillsborough Counties from the southern part of the eradication area; on September 19, 1929, by authorizing sterilization of Florida fruit by réfrigeration in designated cold storages at approved northern points as well as in Florida; on October 11, 1929, by authorizing weekly in place of semi-weekly clean-up of groves and gardens in the eradication area; on October 12, 1929, by modifying the sterilization requirements as to areas theretofore designated as infested; on October 23, 1929, by authorizing the use of heat sterilization for grapefruit; on November 12, 1929, by authorizing the transportation of Florida host fruits and vegetables from the District of Columbia to near-by points in Virginia for local utilization and consumption; on November 18, 1929, by authorizing the movement of sterilized host fruits and vegetables from Florida to other Southern and Western States; on November 27, 1929, by author-

izing the use of heat sterilization for oranges, tangerines, and satsumas; on November 30, 1929, by releasing certain areas designated as infested; on January 23, 1930, by modifying the diversion restrictions on Florida host fruits and vegetables, and by extending to February 28, 1930, the period of movement of host fruits and vegetables from Florida to Southern and Western States; on January 31, 1930, by authorizing the movement, under special Federal permit, of Florida host fruits and vegetables from the District of Columbia and the States of Maryland and Pennsylvania to near-by points in Virginia, West Virginia, and Ohio; on February 6, 1930, by extending the production and harvesting period of Florida cantaloupes to June 15, 1930; on February 19, 1930, by authorizing the production of cotton in and the intrastate movement from eradication areas in Florida; on February 20, 1930, by releasing west Florida, viz, that portion of the State lying west of the Ocklockonee River, from the restrictions on the movement of host fruits and vegetables which apply to the remainder of the State; on February 25, 1930, by extending to April 15, 1930, the production and harvesting period of Florida citrus and other host fruits; on March 3, 1930, by authorizing the shipment by express in less than car lots of Florida host vegetables produced outside of the eradication area; on March 4, 1930, by authorizing the use of an additional method of sterilizing Florida citrus fruits by refrigeration; on April 9, 1930, by modifying the production, harvesting, and shipment restrictions on Florida host fruits and vegetables; on April 10, 1930, by authorizing the reshipment of certain Florida host fruits and vegetables within Southern and Western States; on April 14, 1930, by revoking the requirement of the elimination of summer host plants in the eradication area; on April 30, 1930, by authorizing the shipment of Florida peppers and Lima and broad beans to the Central States, and the reshipment of host vegetables within the Northern and Central States; and on June 20, 1930, by extending the production and harvesting period of Florida grapes and host vegetables.

The pink-bollworm quarantine regulations were amended on September 30, 1929, authorizing the shipment out of the regulated area under permit of second-cut linters which have been passed through a new type of roller equipment; and on October 30, 1929, by adding Maricopa and Pinal Counties, Ariz., to the area designated as regulated; they were revised December 26, 1929, by incorporating five previous amendments, and authorizing, under certain safeguards, the issuance of permits for the interstate movement of samples and of compressed and baled lint or linters from parts of the regulated area without fumigation; under the provisions of this quarantine, notice was given on May 28, 1930, that cotton produced in the counties of Chaves, Eddy, and Otero, in the State of New Mexico, the counties of Andrews, Glasscock, and Martin, and the regulated parts of the counties of Borden, Dawson, and Howard, in the State of Texas, was released from the requirement of fumigation.

The phony peach-disease quarantine regulations were amended October 30, 1929, by the addition of 19 counties of Georgia and 6 of Alabama to the regulated areas and by dividing the regulated areas into two sections, designated as the generally infected area and the lightly infected area. The movement of peach nursery stock and other restricted articles from either area to outside points and from the generally infected area to the lightly infected area was prohibited, except under permit.

The satin-moth quarantine regulations were amended October 31, 1929, by the addition to the regulated area of 38 towns in Maine, 3 in New Hampshire, and 5 in Massachusetts.

The white-pine blister-rust quarantine regulations were revised June 5, 1930, by (1) extending the list of States and counties designated as infected with the white-pine blister rust to include the State of Montana and those parts of Oregon not heretofore so designated; (2) extending the restrictions on the movement of currant and gooseberry plants to cover leaves of those plants; (3) removing the requirement of State inspection and certification with respect to white-pine Christmas trees without roots, and white pine branches, moved during November and December from noninfected States when such movement does not involve passing westward across the Mississippi Valley quarantine line; and (4) modifying the special requirements governing the movement of 5-leafed pines from the generally infected States.

The *Thurberia*-weevil quarantine regulations were amended June 2, 1930, by modifying the conditions governing the issuance of permits for the interstate movement of cotton linters from the area in Arizona regulated on account of the *Thurberia* weevil.

FOREIGN QUARANTINES

The nursery stock, plant, and seed quarantine regulations were amended July 29, 1929, by prohibiting importation, after June 30, 1931, of stocks of mahaleb cherry, myrobalan plum, and other fruit stocks not already excluded; and on May 8, 1930, by requiring a special permit for the entry of *Aglaonema* canes or cuttings.

The fruit and vegetable quarantine regulations were amended July 29, 1929, by bringing under the permit requirement the importation of all species and varieties of chestnuts and acorns on and after September 1, 1929.

MISCELLANEOUS REGULATIONS

The regulations governing the importation of potatoes into the United States were amended June 25, 1930, by eliminating the provision for the importation, without restriction, of potatoes from foreign countries into Porto Rico.

TERMINAL INSPECTION OF MAIL SHIPMENTS OF PLANTS AND PLANT PRODUCTS

The terminal-inspection points in Mississippi, Utah, and California, for the inspection of plants and plant products under the authority of the act of March 4, 1915, were revised during the year. No additional States inaugurated terminal inspection during the fiscal year 1930.

California, Arizona, Montana, Florida, Washington, Arkansas, the District of Columbia, Mississippi, the Territory of Hawaii, Utah, Oregon, Georgia, Idaho, Oklahoma, and Wyoming, in the order named, had previously availed themselves of the provisions of the terminal inspection act. While this inspection, under the terms of the law, must be conducted wholly at the cost of the States concerned, it results in the detection of numerous uncertified or prohibited shipments of articles mailed in violation of Federal domestic plant quarantines. Investigation shows that in the great majority of instances

the senders of these parcels were unaware of the quarantine restrictions. Terminal inspection, therefore, is a valuable adjunct in the enforcement of these quarantines.

CONVICTIONS AND PENALTIES IMPOSED FOR VIOLATIONS OF THE PLANT QUARANTINE ACT

The following convictions and penalties imposed for violations of the plant quarantine act were reported to the administration during the year:

White-pine blister-rust quarantine: Fifteen convictions, with fines aggregating \$450.

European corn-borer quarantine: Three convictions, with fines aggregating \$150.

Japanese-beetle quarantine: Five convictions, with fines aggregating \$860.

Asiatic-beetle and Asiatic-garden-beetle quarantine: One conviction, with fine of \$700.

Mediterranean fruit-fly and melon-fly quarantine: Three convictions; two defendants were given suspended sentences and placed on probation for one year, and the third was given 90 days in jail.

Mediterranean fruit-fly quarantine: Nine convictions; five defendants were fined \$25 each and the other four were given suspended sentences and placed on probation for one year.

Sweetpotato and yam quarantine (domestic): Two convictions, with suspended sentences of one and two years, respectively.

District of Columbia plant regulations: Two convictions, with fines aggregating \$100.

Quarantines affecting Mexican products: Fines aggregating \$1,060 were imposed by customs officials on the Mexican border against 175 persons caught attempting to smuggle in from Mexico prohibited plants and plant products. In another instance the defendant was deported.

REPORT OF THE CHIEF OF THE BUREAU OF PUBLIC ROADS

UNITED STATES DEPARTMENT OF AGRICULTURE,
BUREAU OF PUBLIC ROADS,
Washington, D. C., September 1, 1930.

SIR: I submit herewith the report of the Bureau of Public Roads for the fiscal year ended June 30, 1930.

Respectfully,

THOMAS H. MACDONALD,
Chief of Bureau.

HON. ARTHUR M. HYDE,
Secretary of Agriculture.

During the past fiscal year the Federal-aid road program was continued practically within the limits set by the \$75,000,000 appropriation authorized for the year. Although the amount of the appropriation provided for each year since 1925 has been the same, it has been possible previously to carry on the work of road construction at a more rapid rate because of the availability of a balance of funds authorized and appropriated for the earlier years and not expended within the year for which they were intended.

This year the actual disbursement of Federal-aid funds was \$75,880,863, but little more than the \$73,125,000 apportioned to the States after deduction of the 2½ per cent allowed for administration from the authorized appropriation; and it was more than \$6,000,000 below the expenditure of the preceding fiscal year.

Accordingly the mileage of initial improvements completed—7,317.4 miles—was less than that in any previous year since the rate of appropriation was fixed at \$75,000,000.

In addition to the roads initially improved, advanced stages of construction were completed on 2,011.2 miles of roads previously improved with Federal aid; and 20.8 miles previously built were reconstructed.

At the close of the fiscal year initial improvements were under way on 7,709.2 miles and stage construction was in progress on 2,187.2 miles. There were also 18.4 miles previously built with Federal aid which were in course of reconstruction.

This is the first year in which it has been necessary to spend any part of the Federal appropriations for reconstruction, and the mileage involved is small, but as time goes on it must be expected to increase. It is now 12 years since the first Federal-aid roads were completed, and the ordinary life of some of the types of surface built does not exceed that term.

It is necessary to distinguish clearly between stage construction and reconstruction. The former represents a deliberate postponement of a stage of improvement known at the time to be necessary eventually to meet the needs of the foreseen traffic. The postponement is necessary by reason of the limitations of available funds and the desirability of spreading them over as great a mileage as possible consistent with the provision of a reasonable improvement of highway facilities.

The expenditure of Federal funds for reconstruction is authorized only where the type of construction originally provided was deemed adequate for the then present and probable future traffic requirements, but by reason of an unanticipated increase in traffic has proved to be inadequate. Before approval of further expenditure on such roads it must be satisfactorily established that there has been nothing lacking in their maintenance by the State, and it must be clearly apparent that the necessity for reconstruction results from the increased demands of traffic. It follows that all reconstruction approved must be of a higher type than the original construction.

The total mileage initially improved with Federal aid since 1917 is 86,978.6 miles. This mileage has been reduced by 696 miles by the replacement of certain roads improved prior to 1921 and not included in the designated Federal-aid system by a lesser mileage of more important roads in the system to which the original Federal investment has been transferred. It has been further reduced by 64.2 miles by relocations made in the course of stage construction; so that the actual present length of the roads initially improved with Federal aid and retained as Federal-aid highways is 86,218.4 miles. As 2,205.6 miles were under stage construction or reconstruction at the close of the year and had been temporarily removed from the classification of improved mileage, the total so classified on June 30, 1930, was 84,012.8 miles.

As a result of the increase in the appropriations authorized by Congress at the last session the rate of progress in the construction of Federal-aid roads may be expected to increase next year and in the years immediately following. For the fiscal years 1931, 1932, and 1933 the amounts authorized are \$125,000,000, two-thirds greater than the \$75,000,000 appropriations which have been the rule since 1925. Although the increase in the appropriation for the fiscal year 1931 was not apportioned until last April, the immediate response of the States resulted in the obligation of \$102,498,084 to definite projects during the last fiscal year, as compared with \$70,428,896 obligated during the fiscal year 1929. This higher rate of obligation will, of course, be followed in due course by a greater rate of completion of the improvements now undertaken, and the next year's completion of projects should be materially greater than that reported for this year.

The Federal-aid highway system, in which is included practically all of the mileage now classed as improved with Federal assistance, has been increased in size during the past year and now embraces 193,049 miles of main interstate and intercountry roads.

In addition to the improvements made possible by the Federal-aid appropriations, the bureau has also cooperated with a number of States in the restoration of roads damaged by floods in 1927 and

1929. This work, which is made possible by several special acts of Congress, has resulted to date in the completion of improvements on 57.8 miles of road in Vermont, 24.6 miles in New Hampshire, 39 miles in Kentucky, and 0.3 mile in Mississippi. To the latter State there has also been paid \$341,702.91 for work completed prior to the passage of the flood relief act.

By the completion of 266.8 miles of national-forest roads during the year the total mileage upon which improvements have been completed was increased to 4,357.5 miles. Of this total, 4,026.7 miles are in the 12 Western States and the Territory of Alaska and 330.8 miles are in Eastern States. These improved roads are portions of the forest-road system which has been designated jointly by State and Federal authorities and which includes at present a total of 14,576.1 miles, of which 12,378.8 miles are in the States of the West and Alaska and the remainder in Eastern States.

The work done in cooperation with the National Park Service resulted during the year in the completion of 88.7 miles of important improvements in the parks, bringing the total mileage thus far improved to 302.1 miles, all included in the system of 1,509.7 miles of principal park roads which has been designated.

As in previous years, the bureau has continued to carry on, concurrently with the improvement of Federal-aid, forest, park, and other highways, a program of highway research planned to produce a more exact factual basis for the design of road systems and road structure suited to the expanding needs of modern highway traffic.

Of principal interest during the year were the survey of traffic on the Federal-aid system in the Western States, now nearing completion; the study of soils in respect to their usefulness and stability as road subgrades; the extensive studies and intensive experiments looking to the development of types of surface of low cost suitable for the large existing mileage of lightly traveled roads; the continuation of studies of the characteristics of concrete for road pavements and bridges; and the analyses of the possibilities of greater economy in construction operations, which also have been continued with increasingly useful results.

PROGRESS IN FEDERAL-AID ROAD CONSTRUCTION

Initial improvements were completed during the fiscal year on 7,317.4 miles of the Federal-aid highway system; advanced stages of construction were completed on 2,011.2 miles; and 20.8 miles previously improved were reconstructed. The total mileage upon which improvements were completed was therefore 9,349.4 miles.

At the close of the year construction of initial improvements was in progress on 7,709.2 miles, and other initial improvements had been approved for 1,940 miles. Stage construction was in progress on 2,187.2 miles already initially improved with Federal aid, and similar advanced improvements had been approved for 1,522 miles. In addition, 18.4 miles of roads previously improved were in process of reconstruction, and 7.3 miles were approved for reconstruction.

The mileage of initial improvements completed was less than the mileage of such improvements completed in any year since 1923 and

less than the mileage completed in the preceding fiscal year by 84.9 miles. The mileage of stage construction completed was greater than the mileage completed in any previous year except 1928, and greater than the mileage completed in the preceding year by 27.1 miles. In total mileage of initial and stage construction completed the year's record was lower than that of the preceding year and the lowest since 1924. The record of mileage completed in each fiscal year since 1923 is shown in Table 1.

TABLE 1.—*Mileage of initial and stage construction completed by fiscal years 1923–1930, inclusive*

Fiscal year	Mileage of initial construction completed	Stage construction completed		Mileage of total construction
		Mileage	Percentage of initial construction	
1923.....	8,820.2	117.8	1.3	8,938.0
1924.....	8,610.2	360.4	4.2	8,970.6
1925.....	11,320.3	556.4	4.9	11,876.7
1926.....	9,322.3	1,052.6	11.2	10,374.9
1927.....	8,289.4	1,712.6	20.6	10,002.0
1928.....	8,157.5	2,016.2	24.7	10,173.7
1929.....	7,402.3	1,984.1	26.8	9,386.4
1930.....	7,317.4	2,011.2	27.5	9,328.6

The decline in mileage completed was anticipated. It is the natural result of the contraction of the program to a \$75,000,000 basis, necessitated by the authorization of that annual sum for several years and the final absorption of the unobligated balance of funds appropriated for the earlier years.

As the appropriations authorized for the fiscal years 1931 to 1933, inclusive, have been increased to \$125,000,000, it may be confidently expected that the mileage completed in the ensuing years will be greater.

A year ago the total mileage that had been improved with Federal aid, less extra-system mileage replaced and mileage reductions resulting from relocations, was reported as 79,264.3 miles. A complete review of all records during the past year, resulting in minor corrections of the mileage of many of the earlier projects, shows that the exact total was 79,131.1 miles.

During the past year there have been further reductions by the replacement of mileage off the system amounting to 210.7 miles, and reductions by relocation amounting to 19.4 miles. Thus the addition of 7,317.4 miles of initial improvement during the year brings the total of mileage improved at the close of the year to 86,218.4 miles. With the exception of a very small mileage improved before 1921 and still retained, all of this mileage is in the Federal-aid highway system. As 2,205.6 miles of the above total was in course of stage construction or reconstruction when the fiscal year closed, the total mileage classified as improved with Federal aid at that time was 84,012.8, as shown in Tables 24 and 28.

STAGE CONSTRUCTION

As explained in previous reports the work designated as stage construction consists of the further improvement of roads previously improved to some degree with Federal aid. This work does not increase the mileage reported as improved with Federal aid. On the contrary, it may actually reduce the previously recorded mileage as a result of relocations found to be possible and desirable. As for several years past, a reduction of this sort is reported this year amounting to 19.4 miles.

Work is classed as stage construction only when it represents an advanced Federal-aid improvement of a road previously improved with Federal aid. The initial grant of Federal aid to a particular piece of road is not designated as stage construction, even though the road may have been previously improved to some degree by the State or other agency.

As the Federal-aid operations to date have resulted in the improvement of less than half of the Federal-aid system (although by the States or other agencies nearly the entire system is known to have been improved to some degree), there is still a very considerable mileage improvement of which with Federal aid will be classed as initial improvement. Nevertheless, as the improvement of the system progresses toward the standard ultimately to be desired and as more and more of the system receives Federal aid for its improvement, the mileage classed as stage construction may be expected to increase and to constitute an increasing percentage of the entire improvement operation.

This trend is clearly shown by Table 1, which shows that stage construction was completed during the past year on 2,011.2 miles, a mileage greater than that similarly improved in any previous year except 1928. The table also shows that the ratio of the amount of stage construction to the amount of initial construction completed during the year was 27.5 per cent, and that there has been a steady increase in this percentage since stage construction work was begun in 1923.

The effect of the stage construction from year to year is shown in the steadily increasing percentage of the higher-type improvements from year to year. Thus, at the close of the fiscal year 1926, the mileage improved with high-type pavements of block, concrete, and bituminous concrete was less than 26 per cent of the total improved mileage. Two years later it was a little less than 29 per cent. Last year it was 30.4 per cent; and to-day 33.2 per cent of the mileage classified as improved (exclusive of bridges) is paved with these highest types of surfacing. Nearly 45 per cent of the stage construction completed during the past year was of these types.

As in previous years, the mileage of stage construction completed is mainly in those sections of the country in which the large mileage of road remaining to be improved, the relatively sparse population, and limited funds, required, in the earlier years of work on the roads, a restriction of the initial improvement to grading and draining and the cheaper types of surface in order to spread the benefits of some measure of improvement as widely as possible. In these sections it is now possible to return to the roads previously improved and by

further expenditure, now possible, advance the improvement to a stage more consistent with the increasing requirements of the traffic. The need for the further improvement is greatest in those sections where the restricted initial improvement least adequately met the needs of traffic; and the type of the stage construction is highest in those sections where traffic has attained the greatest density.

Thus, as shown in Table 2, the mileage of stage construction completed in the New England and East North Central States was quite small, and there was none in the Middle Atlantic States. In the first two sections the entire mileage completed was of high-type bituminous macadam or better. These are sections in which highway improvement has long been in progress; in which the roads constituting the Federal-aid system are well developed; and traffic on the system is relatively heavy.

TABLE 2.—*Mileage of stage construction completed during the fiscal year 1930, by groups of States*

Group of States	Mileage of stage construction completed during year	Percentage of total	Percentage of mileage of bituminous macadam or higher type
New England.....	1.7	0.1	100.0
Middle Atlantic.....			
South Atlantic.....	149.9	7.5	84.9
East North Central.....	34.6	1.7	100.0
East South Central.....	54.2	2.7	29.0
West North Central.....	981.2	48.8	36.5
West South Central.....	441.5	21.9	98.6
Mountain.....	317.7	15.8	1.5
Pacific.....	30.4	1.5	31.5
Total.....	2,011.2	100.0	49.3

The greatest mileage of stage construction completed was in the West North Central States; and much of it was of a type lower than bituminous macadam. This is a section in which a few years ago the roads were generally unimproved. As a first step it was necessary to limit the expenditure per mile rather narrowly in order to make it cover as much as possible of the large mileage awaiting improvement. Now it becomes possible to return to the roads initially improved by grading and draining only and add surfaces of low and intermediate type which will reasonably meet the needs of traffic for several years more.

In the West South Central States, where, next to the group adjoining them on the north, the mileage of completed stage construction was greatest, a similar process of adjustment is under way, but the type of improvement is generally higher than in the neighboring group. The situation in this section more nearly resembles the condition which prevails in the South Atlantic States.

In the Mountain States traffic is still relatively light, and it is possible to meet the increased requirements with supplementary improvements of low cost. Much of the stage construction in this area consists of the building of low-cost bituminous-mixed surfaces, a type which has proved very effective in this region.

RECONSTRUCTION OF FEDERAL-AID ROADS

This year, for the first time since the beginning of the Federal-aid road work, there is a small amount of reconstruction work to report. By the close of the year reconstruction had been completed on 20.8 miles of road previously improved with Federal aid in 5 States; and at the close of the year there were 18.4 miles in 4 States that were in course of reconstruction and 7.3 miles in 2 States that had been approved for reconstruction.

Reconstruction differs from stage construction in the fact that the latter represents a deliberate postponement of a part of an improvement known to be required to meet the demands of anticipated traffic, whereas the former becomes necessary by reason of the overtaxing of an improvement originally believed to be adequate by an unanticipated traffic.

To projects built under the stage-construction plan the Federal contribution is limited to a total payment of \$15,000 a mile (or other maximum payment prescribed by the law.) The supplementary stages of improvement are definitely anticipated and provided for in the original project agreement, and a portion of the permissible maximum allotment of Federal funds is reserved for payment when the deferred improvement is completed.

When, however, a road, which has been previously constructed to a standard regarded at the time as consistent with traffic requirements, is subjected to a traffic for which it is unsuited and by such traffic is worn out in spite of the best efforts of the State to maintain it, reconstruction is required; and the Federal law permits allotment of additional Federal funds to the full amount payable for original construction.

The increase in highway traffic in the last 5 or 10 years has exceeded all reasonable estimates; and types of construction which 10 or even 5 years ago were considered adequate to meet the probable future traffic have in certain instances been found to be unequal to the demands of a traffic exceeding, in number of vehicles and particularly in the weight and speed of the heavier units, the estimates at the time of construction.

In such cases the roads previously aided are eligible for further allotment of aid toward their reconstruction; but no such additional aid is granted unless there is a clear record of the satisfactory maintenance of the original improvement by the State.

The mileage, total cost, and Federal-aid allotments to reconstruction completed during the fiscal year and in progress and approved at the end of the year are reported in Tables 3, 4, and 5. The mileage reported in these tables does not increase the total mileage improved with Federal aid. The total costs and Federal-aid allotments relate to the reconstruction only.

TABLE 3.—*Federal-aid projects on which reconstruction had been completed on June 30, 1930*

State	Total cost	Federal aid	Miles
Louisiana.....	\$304, 044. 39	\$113, 160	7. 5
Maine.....	92, 751. 08	29, 175	1. 9
Maryland.....	304, 148. 92	98, 370	6. 6
Massachusetts.....	158, 300. 30	41, 340	2. 7
New Hampshire.....	150, 280. 99	30, 960	2. 1
Total.....	1, 009, 525. 68	313, 005	20. 8

TABLE 4.—*Federal-aid projects on which reconstruction was in progress on June 30, 1930*

State	Estimated total cost	Federal aid allotted	Miles
Maryland.....	\$309, 088. 95	\$145, 550. 00	5. 9
Massachusetts.....	130, 236. 04	39, 225. 00	2. 6
Oklahoma.....	253, 454. 06	106, 295. 29	8. 5
Vermont.....	60, 086. 66	21, 495. 00	1. 4
Total.....	752, 865. 71	312, 565. 29	18. 4

TABLE 5.—*Federal-aid projects which were approved for reconstruction on June 30, 1930*

State	Estimated total cost	Federal aid allotted	Miles
Maine.....	\$78, 823. 61	\$23, 190	1. 5
Maryland.....	329, 302. 82	130, 000	5. 8
Total.....	408, 126. 43	153, 190	7. 3

The original types of the roads reconstructed, in process of reconstruction, and approved for reconstruction, the age of the roads at the time of reconstruction, and the type of the road after reconstruction are shown in Tables 6, 7, and 8.

TABLE 6.—*Federal-aid projects on which reconstruction had been completed on June 30, 1930, by types of construction*

State	Age	Original type					
		Gravel, untreated		Bituminous macadam		Bituminous concrete	
		New type	Miles	New type	Miles	New type	Miles
Louisiana.....	Years 4	Bituminous concrete.	7. 5				
Maine.....	7			Portland cement concrete.	1. 9		
Maryland.....	8			do	6. 6		
Massachusetts.....	8			do	2. 7		
New Hampshire..	9					Portland cement concrete.	2. 1

TABLE 7.—*Federal-aid projects on which reconstruction was in progress on June 30, 1930, by types of construction*

State	Age	Original type					
		Gravel, untreated		Bituminous concrete		Portland cement concrete	
		New type	Miles	New type	Miles	New type	Miles
Maryland.....	<i>Years</i> 10	-----	-----	-----	-----	Portland cement concrete.	5.9
Massachusetts.....	11	-----	-----	Bituminous ma- cadam.	2.6	-----	-----
Oklahoma.....	8	Portland cement concrete.	8.4	-----	-----	-----	-----
Do.....	8	Bridge.....	.1	-----	-----	-----	-----
Vermont.....	4	Portland cement concrete.	1.4	-----	-----	-----	-----

TABLE 8.—*Federal-aid projects which were approved for reconstruction on June 30, 1930, by types of construction*

State	Age	Original type, bituminous macadam	
		New type	Miles
Maine.....	<i>Years</i> 10	Portland cement concrete.....	1.5
Maryland.....	10	do.....	5.8

CHANGES IN THE FEDERAL-AID HIGHWAY SYSTEM

In accordance with section 3 of the amendatory act of May 21, 1928, the mileage of the Federal-aid system, originally limited to 7 per cent of the certified total mileage of roads in each State, may be increased by an amount equal to the mileage of the designated system in each State lying within the boundaries of national forests, Indian reservations, and other Federal reservations.

The total mileage of the system within such reservations, as determined up to the close of the fiscal year, is 5,456.11 miles, and the addition of this mileage to the original 7 per cent limit raises the permissible mileage of the initial system to 206,018 miles.

By addition to the system during the past year, made possible in part by the provisions of section 3, the mileage of the initial system has been increased to 191,846.16 miles. This mileage has been further increased by extensions of the system in three States in which the initial 7 per cent system has been fully improved to the satisfaction of the Secretary of Agriculture.

The States in which such extensions have been approved are: Delaware, in which the extension is 284.28 miles; Maryland, with an extension of 668.12 miles; and Rhode Island, in which there has been an extension of 251.30. The sum of these extensions, being 1,203.7 miles, added to the initial system thus far designated raises the mileage of the total system to 193,049.86 miles as of June 30, 1930, an increase of 4,192.7 miles in the last year.

The mileage of the system within Federal reservations in each of the States in which such mileage has been reported and approved up to June 30, 1930, is given in Table 9.

TABLE 9.—*Mileage of Federal-aid highway system within Federal reservations, being the amounts by which the 7 per cent limiting mileage may be exceeded in each State or Territory*

State	Mileage within Federal reservations	State	Mileage within Federal reservations	State	Mileage within Federal reservations
Arizona.....	547. 20	Minnesota.....	74. 80	Pennsylvania.....	79. 46
Arkansas.....	119. 70	Mississippi.....	10. 40	South Dakota.....	474. 50
California.....	457. 00	Montana.....	864. 32	Tennessee.....	77. 64
Colorado.....	363. 50	Nebraska.....	11. 25	Utah.....	68. 90
Georgia.....	57. 80	Nevada.....	25. 26	Virginia.....	30. 72
Idaho.....	468. 40	New Hampshire.....	33. 42	Washington.....	353. 21
Illinois.....	4. 50	New Mexico.....	350. 08	West Virginia.....	29. 06
Iowa.....	2. 00	New York.....	16. 47	Wisconsin.....	45. 50
Kansas.....	14. 70	North Carolina.....	159. 34	Wyoming.....	275. 90
Kentucky.....	6. 00	North Dakota.....	23. 39	Hawaii.....	4. 34
Maine.....	4. 50	Oklahoma.....	16. 25		
Michigan.....	26. 50	Oregon.....	360. 10	Total.....	5, 456. 11

The mileage of the designated Federal-aid system in each State, including the authorized extensions in three States, and the mileage within Federal reservations, is given in Table 24, which also shows the distribution, by States, of the 84,012.8 miles improved up to June 30, 1930.

The mileage reported as improved with Federal aid still includes a small amount improved prior to 1921 and not incorporated in the designated system. The amount of such extra-system mileage is being gradually reduced by the substitution of mileage within the system and the transfer of the Federal aid paid for the improvement of the original roads to the improvement of the substituted mileage.

The effect of this procedure is to return to the Federal Government the amount of its investment in the roads outside the Federal-aid system, so that these roads are no longer considered Federal-aid roads. The States are thus released of their obligation to the Government to maintain them and may, if they so desire, return them to the control of the county or other local authorities.

A year ago it was reported that the Federal aid originally paid for the improvement of 485.3 miles of such roads outside of the system had been transferred to other roads within the system. In the past year the continuation of this procedure has returned to the Government the amount originally expended on other roads outside the system totalling 210.7 miles, and this money has been allotted to the initial or stage construction of other roads within the system.

The distribution, by States, of the mileage replaced during the fiscal year, the total cost of its improvement, and the Federal aid allotted to it and now returned are shown in Table 10. The type classification of the newly replaced mileage is shown in Table 11. As will be noted, it is predominantly of low type, 180 of the 210.7 miles, or 85 per cent, having been improved with types of surface less durable than bituminous macadam.

TABLE 10.—*Total cost, Federal aid, and mileage of roads replaced during the fiscal year ended June 30, 1930, for which other improvements have been substituted*

State	Total cost	Federal aid	Mileage	State	Total cost	Federal aid	Mileage
Arkansas.....	\$633,681.83	\$291,548.32	63.9	Pennsylvania..	\$127,359.57	\$46,600.00	2.3
Colorado.....	68,298.37	38,055.90	.3	South Dakota..	75,419.25	37,709.62	15.0
Connecticut....	8,873.18	2,800.00	.1	Vermont.....	15,225.77	6,507.28	.3
Kansas.....	122,789.84	44,029.43	2.1	Virginia.....	405,760.05	197,912.13	16.8
Massachusetts..	70,475.58	30,160.87	.5	West Virginia..	40,487.55	18,555.41	2.2
Minnesota.....	321,656.35	138,763.95	28.4	Wisconsin.....	1,126,503.55	417,790.21	78.3
Mississippi.....	2,991.26	1,495.63	.3				
Oklahoma.....	107,419.34	53,709.67	.2	Total.....	3,126,941.49	1,325,638.42	210.7

TABLE 11.—*Mileage of roads replaced during the fiscal year ended June 30, 1930, for which other improvements have been substituted, by types of construction, by States*

State	Graded and drained	Gravel, untreated	Macadam, untreated	Macadam, treated	Bituminous macadam	Bituminous concrete	Portland cement concrete	Block	Bridges and approaches	Total
Arkansas.....		31.5		32.3					0.1	63.9
Colorado.....									.3	.3
Connecticut....			0.1							.1
Kansas.....	0.4						1.0	0.7		2.1
Massachusetts..					0.4				.1	.5
Minnesota.....	1.4	27.0								28.4
Mississippi.....		.3								.3
Oklahoma.....									.2	.2
Pennsylvania..						2.3				2.3
South Dakota..		15.0								15.0
Vermont.....			.3							.3
Virginia.....	.3		11.2		5.2				.1	16.8
West Virginia..					2.2					2.2
Wisconsin.....	19.4	40.8					18.1			78.3
Total.....	21.5	114.6	11.6	32.3	7.8	2.3	19.1	.7	.8	210.7

The replacements of the last year bring the total of mileage thus far replaced to 696 miles. The location of this mileage, its total cost, and the Federal aid originally allotted to it are shown in Table 12, and its type classification in Table 13. Of the total mileage more than 90 per cent was improved with types of surface less durable than bituminous macadam, a fact which is indicative of the relatively slight importance of these roads.

TABLE 12.—*Total cost, Federal aid, and mileage of roads replaced to June 30, 1930, for which other improvements have been substituted*

State	Total cost	Federal aid	Mileage	State	Total cost	Federal aid	Mileage
Alabama.....	\$33,947.60	\$16,433.17	5.5	New York.....	\$43,692.89	\$18,245.34	1.1
Arkansas.....	1,003,545.20	455,193.72	99.1	North Dakota..	42,372.46	20,968.87	7.1
Colorado.....	68,298.37	38,055.90	.3	Oklahoma.....	107,419.34	53,709.67	.2
Connecticut....	8,873.18	2,800.00	.1	Pennsylvania..	127,359.57	46,600.00	2.3
Kansas.....	125,874.60	45,571.81	3.6	South Carolina..	4,779.96	2,294.32	-----
Louisiana.....	31,433.22	14,301.06	1.1	South Dakota..	75,419.25	37,709.62	15.0
Massachusetts..	82,625.68	36,235.92	.6	Texas.....	99,290.75	33,333.34	7.4
Michigan.....	357,020.74	163,618.76	20.9	Vermont.....	15,225.77	6,507.28	.3
Minnesota.....	1,641,050.96	630,046.33	206.8	Virginia.....	642,118.35	297,110.16	25.7
Mississippi.....	2,991.26	1,495.63	.3	West Virginia..	40,487.55	18,555.41	2.2
Montana.....	783.93	391.96	.2	Wisconsin.....	3,231,426.13	1,256,707.13	275.7
Nebraska.....	293.68	146.84	.2	Wyoming.....	11,908.56	5,160.81	10.4
Nevada.....	10,046.35	5,023.17	-----				
New Mexico....	52,715.38	25,964.81	9.9	Total.....	7,861,000.73	3,232,181.03	696.0

TABLE 13.—*Mileage of roads replaced to June 30, 1930, for which other improvements have been substituted, by types of construction, by States*

State	Graded and drained	Sand-clay, untreated	Gravel, untreated	Macadam, untreated	Macadam, treated	Bituminous macadam	Bituminous concrete	Portland cement concrete	Block	Bridges and approaches	Total
Alabama			5.5								5.5
Arkansas			63.5		35.3			0.1		0.2	99.1
Colorado										.3	.3
Connecticut				0.1							.1
Kansas	1.9							1.0	0.7		3.6
Louisiana			1.1								1.1
Massachusetts						0.4				.2	.6
Michigan			14.4		2.6		3.9				20.9
Minnesota	18.6		182.7					5.5			206.8
Mississippi			.3								.3
Montana	.1		.1								.2
Nebraska	.2										.2
New Mexico			9.9								9.9
New York								1.1			1.1
North Dakota	6.8									.3	7.1
Oklahoma										.2	.2
Pennsylvania							2.3				2.3
South Dakota			15.0								15.0
Texas			7.4								7.4
Vermont				.3							.3
Virginia	.3			12.6		12.7				.1	25.7
West Virginia						2.2					2.2
Wisconsin	68.9	19.8	150.1					36.8		.1	275.7
Wyoming	10.4										10.4
Total	107.2	19.8	450.0	13.0	37.9	15.3	6.2	44.5	.7	1.4	696.0

The Federal aid originally paid for the improvement of the 696 miles replaced has been allotted with additional funds to 583.2 miles of initial construction and 72.2 miles of stage construction in the same States. Of these mileages, 427.2 miles of initial construction and 66.2 miles of stage construction had been completed by the close of the fiscal year. The estimated total cost of this work, the Federal aid substituted, additional Federal aid allotted, and the mileage involved are shown in Table 14; and similar information relative to the 156 miles of initial construction and 6 miles of stage construction still in progress at the close of the fiscal year is given in Table 15.

TABLE 14.—*Total cost, Federal aid substituted, additional Federal aid allotted, and initial and stage mileage of substituted improvements completed to June 30, 1930*

State	Estimated total cost	Federal aid substituted	Additional Federal aid allotted	Mileage	
				Initial	Stage
Alabama	\$199,154.95	\$16,433.17	\$70,244.83	16.7	
Arkansas	2,239,167.08	357,902.56	745,084.32	67.2	3.8
Kansas	159,960.10	24,585.53	35,970.03	13.2	
Louisiana	204,578.15	5,000.00	97,289.07	2.9	
Massachusetts	245,104.53	6,075.05	69,410.72	4.8	
Michigan	612,511.33	69,386.96	138,071.04	14.5	
Minnesota	2,230,265.11	569,210.59	74,082.43	58.1	6.6
Montana	26,261.68	92.64	11,179.68	2.0	
Nebraska	5,557.42	146.84	2,631.87	.9	
Nevada	38,952.47	5,023.17	29,009.88	6.3	
New Mexico	141,891.17	25,840.55	64,486.07	7.3	
New York	333,869.60	18,245.34	125,355.00	9.5	
North Dakota	178,100.11	20,968.87	54,308.01	33.0	
Oklahoma	207,575.96	53,709.67	42,255.33	2.9	6.7
South Carolina	237,929.62	2,294.32	82,418.67		7.6
Texas	451,779.61	33,333.34	179,177.28		18.1
Virginia	1,344,172.23	297,110.16	60,503.33	37.6	
West Virginia	328,332.97	18,555.41	52,538.17	6.3	
Wisconsin	4,389,202.68	1,099,885.55	956,022.44	144.0	13.6
Wyoming	18,158.59	5,160.81			9.8
Total	13,592,525.36	2,628,960.53	2,890,038.17	427.2	66.2

TABLE 15.—Total cost, Federal aid substituted, additional Federal aid allotted, and initial and stage mileage of substituted improvements under construction on June 30, 1930

State	Estimated total cost	Federal aid substituted	Additional Federal aid allotted	Mileage	
				Initial	Stage
Arkansas	\$532,607.81	\$97,291.16	\$160,939.91	17.1	
Colorado	514,593.09	38,055.90	222,056.55	10.2	
Connecticut	180,495.42	2,800.00	87,447.71	.5	
Kansas	336,221.44	20,986.28	134,656.48	8.0	
Louisiana	1,145,393.93	9,301.06	563,395.90	.7	
Massachusetts	911,886.68	30,160.87	226,385.86	12.5	
Michigan	514,366.38	94,231.80	132,001.20	12.9	
Minnesota	884,895.98	60,835.74	145,842.84	12.1	6.0
Mississippi	171,041.09	1,495.63	84,024.91	1.5	
Montana	201,469.62	299.32	106,953.18	16.6	
New Mexico	106,217.79	124.26	67,249.68	.5	
Pennsylvania	334,117.63	46,600.00	42,620.00	6.0	
South Dakota	86,386.15	37,709.62	9,802.75	15.8	
Vermont	666,826.02	6,507.28	135,010.07	13.2	
Wisconsin	727,390.59	156,821.58	178,567.96	28.4	
Total	7,313,909.62	603,220.50	2,296,955.00	156.0	6.0

The type classification of the substituted initial and stage construction completed and in progress at the close of the fiscal year is shown in Tables 16, 17, and 18. Consistent with the greater importance of the roads involved, these improvements are of considerably higher type than those replaced.

TABLE 16.—Mileage of completed initial improvements substituted for replaced roads to June 30, 1930, by types of construction, by States

State	Graded and drained	Sand-clay, untreated	Gravel		Macadam, treated	Low-cost bituminous mixture	Bituminous macadam	Portland cement concrete	Bridges and approaches	Total
			Un-treated	Treated						
Alabama	16.6								0.1	16.7
Arkansas	10.1		8.2					48.0	.9	67.2
Kansas	11.1							.7	1.4	13.2
Louisiana									2.9	2.9
Massachusetts							4.8			4.8
Michigan			3.1					11.4		14.5
Minnesota	7.6			17.6				32.8	.1	58.1
Montana			1.8					.2		2.0
Nebraska		0.9								.9
Nevada						6.3				6.3
New Mexico			4.0			2.9		.4		7.3
New York							.2	9.3		9.5
North Dakota	20.0			12.9					.1	33.0
Oklahoma								2.9		2.9
Virginia	7.3				3.6		20.6	5.8	.3	37.6
West Virginia							6.3			6.3
Wisconsin			26.5	4.0				112.9	.6	144.0
Total	72.7	.9	43.6	34.5	3.6	9.2	31.9	224.4	6.4	427.2

TABLE 17.—Mileage of completed stage improvements substituted for replaced roads to June 30, 1930, by types of construction, by States

State	Graded and drained	Low-cost bituminous mixture	Portland cement concrete	Total
Arkansas			3.8	3.8
Minnesota	6.6			6.6
Oklahoma			6.7	6.7
South Carolina			7.6	7.6
Texas			18.1	18.1
Wisconsin			13.6	13.6
Wyoming		9.8		9.8
Total	6.6	9.8	49.8	66.2

TABLE 18.—*Mileage of initial improvement under construction on June 30, 1930, substituted for replaced roads, by types of construction, by States*

State	Graded and drained	Gravel, untreated	Bituminous macadam	Portland cement concrete	Bridges and approaches	Total
Arkansas.....				17.0	0.1	17.1
Colorado.....				9.5	.7	10.2
Connecticut.....				.4	.1	.5
Kansas.....	6.7			1.0	.3	8.0
Louisiana.....					.7	.7
Massachusetts.....			7.3	5.1	.1	12.5
Michigan.....				12.8	.1	12.9
Minnesota.....		12.0			.1	12.1
Mississippi.....	1.3				.2	1.5
Montana.....		16.6				16.6
New Mexico.....					.5	.5
Pennsylvania.....				6.0		6.0
South Dakota.....		15.8				15.8
Vermont.....				13.4		13.4
Wisconsin.....		12.7		15.4	.1	28.2
Total.....	8.0	57.1	7.3	80.6	3.0	156.0

NOTE.—The only mileage of stage improvement under construction on June 30, 1930, substituted for abandoned roads is 6 miles of Portland cement concrete in Minnesota.

As the substituted stage improvements are applied to roads already improved to a certain degree with Federal aid, the net effect of all the above-described substitutions upon the mileage considered as improved with Federal aid is to reduce the mileage at present improved or under improvement by the difference between 696 and 583.2, or 112.8 miles. A comparison of the replaced and substituted initially improved mileages, by States, is given in Table 19.

TABLE 19.—*Comparison of the replaced and substituted initially improved mileages on June 30, 1930, by States*

State	Replaced mileage	Substituted mileage	Changes in the mileage of roads improved with Federal aid	
			Increase (miles)	Decrease (miles)
Alabama.....	5.5	16.7	11.2	
Arkansas.....	99.1	84.3		14.8
Colorado.....	.3	10.2	9.9	
Connecticut.....	.1	.5	.4	
Kansas.....	3.6	21.2	17.6	
Louisiana.....	1.1	3.6	2.5	
Massachusetts.....	.6	17.3	16.7	
Michigan.....	20.9	27.4	6.5	
Minnesota.....	206.8	70.2		136.6
Mississippi.....	.3	1.5	1.2	
Montana.....	.2	18.6	18.4	
Nebraska.....	.2	.9	.7	
Nevada.....	(1)	6.3	6.3	
New Mexico.....	9.9	7.8		2.1
New York.....	1.1	9.5	8.4	
North Dakota.....	7.1	33.0	25.9	
Oklahoma.....	.2	2.9	2.7	
Pennsylvania.....	2.3	6.0	3.7	
South Carolina.....	(1)	(2)		
South Dakota.....	15.0	15.8	.8	
Texas.....	7.4	(2)		7.4
Vermont.....	.3	13.4	13.1	
Virginia.....	25.7	37.6	11.9	
West Virginia.....	2.2	6.3	4.1	
Wisconsin.....	275.7	172.2		103.5
Wyoming.....	10.4	(2)		10.4
Total.....	696.0	583.2	162.0	274.8

¹ Less than 0.1 mile.² Stage improvement substituted.

TYPES OF FEDERAL-AID ROADS

The 7,317.4 miles initially improved during the year consists of 2,556.2 miles of graded and drained earth roads; 227.1 miles of untreated sand-clay roads; 1,382.5 miles of untreated gravel roads; 66.3 miles of bituminous-treated gravel roads; 36.2 miles of water-bound macadam roads; 14.1 miles of surface-treated macadam roads; 160.4 miles of low-cost bituminous mixed surfaces; 318.5 miles of bituminous macadam roads; 135.2 miles of bituminous concrete pavement; 2,340.3 miles of Portland cement concrete pavement; and 40 miles of block pavement. The remaining 40.6 miles is made up of numerous bridges and their approaches, each structure more than 20 feet in length.

Of these roads initially improved, 39 per cent of the mileage is improved with bituminous macadam or one of the higher types of pavement; 3 per cent with intermediate bituminous-treated types of surface; and 58 per cent with untreated macadam and lower types of surface, including a considerable mileage that is only graded and drained.

The choice of surface type, in all cases representing the concurrence of the bureau and the respective State highway departments, is made after consideration of the traffic requirements, the availability of funds, the general level of road improvement in the area, and other pertinent factors. In general, the types built are in close accord with the demands of traffic, and the more resistant and hence more expensive improvements are found to the greater extent in those sections of the country where traffic is heaviest. This fact is indicated by Table 20, in which the number of registered motor vehicles per mile of the Federal-aid system in each geographic area is used as an approximate index of the general density of traffic in the area.

TABLE 20.—*Relation of the types of initial improvements completed during the fiscal year 1930 and the general density of motor-vehicle traffic on the Federal-aid highway system, by groups of States*

Group of States	Number of motor vehicles per mile of Federal-aid system ¹	Percentage of mileage of initial improvements completed		
		Bituminous macadam and higher types	Intermediate bituminous-treated types	Untreated macadam and lower types
Middle Atlantic.....	395	90	-----	10
New England.....	268	87	10	3
Pacific.....	240	25	20	55
East North Central.....	230	84	-----	16
South Atlantic.....	107	61	3	36
West South Central.....	97	28	-----	72
East South Central.....	83	23	-----	77
West North Central.....	75	15	3	82
Mountain.....	40	3	6	91
Total.....	137	39	3	58

¹ As registered in the several States during the calendar year 1929.

The effect of stage construction and the substitution of higher types of improvement for replaced early improvements outside of the Federal-aid system is shown by the fact that whereas the pavement types and bituminous macadam constituted only 39 per cent of the total of mileage initially improved, the net increase in the mileage of these types was 61 per cent of the total net increase in mileage, exclusive of bridges, during the year. The intermediate bituminous-treated types of surface which formed only 3 per cent of the year's initial improvements constituted 9 per cent of the net increase in mileage; and the untreated macadam and lower types including graded and drained earth roads, which made up 58 per cent of the initially improved mileage were only 30 per cent of the net increase in mileage. Graded and drained earth roads, which constituted 35 per cent of the initially improved mileage formed only 17 per cent of the net increase in mileage.

As shown by Table 21, the percentage increases in the mileage of low-cost bituminous-mixed surfaces and bituminous-treated gravel surfaces were greater than the increases of any other type. The large percentages in the case of these types, however, are the result of the relatively small mileages involved. Of the types of which there are large mileages, Portland cement concrete shows the largest percentage increase. The same table also shows that the increase of the four higher types of improvement was 13 per cent, as compared with 4.7 per cent for the lower types, and a general increase of 7.8 per cent.

TABLE 21.—Mileage of the several types of Federal-aid roads improved at the close of the fiscal years 1929 and 1930, and percentage of change

Type	Mileage at close of fiscal year 1929	Mileage at close of fiscal year 1930	Percentage change dur- ing fiscal year 1930
Graded and drained.....	11,407.8	12,448.5	9.1
Sand-clay:			
Untreated.....	7,049.0	7,166.2	1.7
Treated.....	16.5	16.5	-----
Gravel:			
Untreated.....	27,946.9	28,607.9	2.4
Treated.....	364.6	482.5	32.3
Macadam:			
Untreated.....	1,747.1	1,754.1	.4
Treated.....	639.6	603.4	-5.7
Low-cost bituminous mix.....	294.3	742.0	152.1
Bituminous macadam.....	3,671.9	4,057.1	10.5
Bituminous concrete.....	3,039.1	3,204.7	5.4
Portland cement concrete.....	20,612.0	23,693.3	14.9
Block.....	866.6	904.7	4.4
Total.....	77,655.4	83,680.9	7.8

Of the 84,012.8 miles classified as improved with Federal aid at the close of the year, 12,448.5 miles are graded and drained earth roads; 7,166.2 miles are untreated sand-clay roads; 16.5 miles are bituminous-treated sand-clay roads; 28,607.9 miles have untreated gravel surfaces and 482.5 miles bituminous-treated surfaces of the same type; 1,754.1 miles have water-bound macadam surfaces; 603.4 miles are surfaced with bituminous-treated macadam; 742 miles are improved with low-cost bituminous-mixed surfaces; 4,057.1 miles are

surfaced with bituminous macadam; 3,204.7 miles are paved with bituminous concrete; 23,693.3 miles are Portland cement concrete pavements; and 904.7 miles are block pavements. The remaining 331.9 miles consists of bridges, each more than 20 feet in span, and their approaches.

BRIDGE CONSTRUCTION

The bridges completed as initial improvements during the year, with their approaches, have an aggregate length of 40.6 miles. Those added by stage construction aggregate 5.3 miles, making a total of 45.9 miles of bridges and their approaches completed during the fiscal year. This may be compared with the corresponding figure of 47.1 miles completed during the fiscal year 1929. The bridges under construction and approved for construction at the end of the year, as both initial and stage construction, have, with their approaches, a total length of 85.7 miles.

Including the structures just completed, the Federal-aid bridges now in use have a total length, with their approaches, of 331.9 miles.

A list of the bridges completed during the year which cost \$75,000 or more is given in Table 22. These, the longest and most expensive of the projects completed, vary in length from about one-tenth of a mile to nearly 2 miles and have an aggregate length, with their approaches, of 10.4 miles. The rest of the mileage completed is made up of numerous smaller and less expensive bridges, all more than 20 feet in span.

TABLE 22.—Federal-aid bridges completed during the fiscal year 1930 at a cost of \$75,000 or more each

State	Location	Stream or railroad	Estimated total cost	Length of bridge and approaches
			<i>Dollars</i>	<i>Miles</i>
Arkansas.....	Marianna-Memphis Highway.....	St. Francis River.....	251,700	0.3
Do.....	Princeton-Camden Road.....	Fourbridges, Ouachita River.....	270,200	.9
Arkansas-Tennessee.....	Memphis, Tenn., and Chatfield, Ark.....	Mississippi River.....	1,237,300	1.8
California.....	The Coast Road.....	Overhead crossing, Southern Pacific Railroad.....	77,500	.1
Do.....	Elk Valley Road.....	Smith River.....	160,400	.1
Do.....	Valley Road between Bakersfield and San Fernando.....	Santa Clara River.....	201,300	.4
Connecticut.....	Between Hartford and Putnam.....	Willimantic River.....	76,100	.1
Delaware.....	Newport Highway.....	Christiana River.....	144,500	.1
Florida.....	State Road No. 2.....	Dead River.....	84,000	.1
Indiana.....	The Dixie Bee Line Highway.....	White River.....	253,300	.4
Kansas.....	Wamego-Eskridge Highway.....	Kansas River.....	132,100	.2
Louisiana.....	Tullos-Rochelle Highway.....	Little River.....	118,500	.1
Massachusetts.....	Northampton Highway.....	Manhan River.....	119,900	.2
Michigan.....	Ann Arbor-Battle Creek Road.....	Overpass, Michigan Electric Railway & Michigan Central Railroad.....	102,200	.2
Do.....	The River Road.....	Saginaw River.....	91,500	-----
Do.....	Monroe-Detroit Road in Wayne County.....	Underpass, Wabash Railway yard.....	582,000	.3
Do.....	Bedford-Pontiac Road.....	Underpass, Grand Trunk Railroad.....	95,100	.2
Minnesota-North Dakota.....	East Grand Forks, Minn.-Grand Forks, N. Dak.....	Red River of the North.....	325,200	.2
Mississippi.....	The Delta Road in Warren County.....	Yazoo River (two bridges).....	365,200	.3
New York.....	Bradford-Carrollton.....	Overpass, Erie Railroad.....	184,000	.5
North Dakota.....	State Route No. 5.....	Des Lac Lake Crossing.....	118,000	.3

TABLE 22.—*Federal-aid bridges completed during the fiscal year 1930 at a cost of \$75,000 or more each—Continued*

State	Location	Stream or railroad	Estimated total cost	Length of bridge and approaches
			<i>Dollars</i>	<i>Miles</i>
Ohio.....	Ohio River Road, Belmont County.	Overpass, Pennsylvania Railroad Co., Wheeling & Lake Erie Railroad Co., and Wheeling Traction Co.	85,600	0.1
Do.....	Cleveland - East Liverpool Highway.	Overpass, Pennsylvania Railroad Co., Wheeling & Lake Erie Railroad Co., and Northern Ohio Traction & Light Co.	500,000	.3
Do.....	At Vermilion.....	Vermilion River.....	114,500	.2
Do.....	U. S. Route No. 11 at Austintown.	Meander Creek.....	80,800	-----
Oregon.....	At Maupin.....	Deschutes River.....	108,400	.3
Do.....	Between Reedsport and Drain	Umpqua River.....	124,700	.3
Pennsylvania.....	Lock Haven-North Bend Road.	Susquehanna River.....	303,400	.2
South Carolina....	Between Newberry and Columbia.	Broad River and Columbia Canal.	283,200	.2
Tennessee.....	Knoxville-Asheville Road.....	French Broad River.....	117,700	.3
Do.....	Memphis - Bristol Highway near Brownsville.	Hatchie River.....	250,900	.6
Texas.....	The Brenham - Hempstead Road.	Brazos River.....	341,600	.2
Do.....	Highway No. 12, Victoria County.	Coleta Creek.....	75,300	.1
Virginia.....	State Route No. 36 in Clarke County.	Shenandoah River.....	121,600	.2
Do.....	Alexandria - Fredericksburg Road.	Occoquan Creek.....	83,800	.2
Washington.....	Pacific Highway, between Kelso and Vancouver.	Kalama River.....	79,600	.1
Do.....	Between Colville and Laurier.	Columbia River.....	267,700	.2
Wisconsin.....	Atwater crossing near Shorewood.	Underpass, Chicago & Northwestern Railroad.	155,500	.1

PROVISION FOR CONSTRUCTION OF CERTAIN ROADS AT THE SOLE EXPENSE OF THE FEDERAL GOVERNMENT

On June 24, 1930, an act was approved which authorizes the Secretary of Agriculture to cooperate with the State highway departments and the Department of the Interior in the survey, construction, reconstruction, and maintenance of main roads through unappropriated or unreserved public lands, nontaxable Indian lands, or other Federal reservations other than forest reservations. No contribution from the States will be required toward the improvement of roads built under the provisions of this act over lands of the character described.

The act provides that the appropriations which the Congress may authorize under its provisions shall be apportioned among those States having more than 5 per cent of their area in lands of the several kinds described, and shall be prorated to such States in the proportion that such lands in each State bear to the total area of land of like character in all the eligible States.

The act provides further that in the allocation of funds authorized preference shall be given to those projects which are located in the Federal-aid highway system as now or hereafter designated.

No appropriation has yet been authorized and no construction can be undertaken until funds are provided. Meanwhile consideration is being given to the procedure that will be required to give effect to the provisions of the act.

As the department is authorized to cooperate only with State highway departments and the Department of the Interior it appears that the application of the act is limited to those main roads included in the Federal-aid highway system as now designated and those now under the jurisdiction of the State highway departments or which may be taken into the State systems.

The survey of traffic on the Federal-aid system in the Western States, now nearing completion, will supply data with reference to the general average of traffic on the main roads of these States which may be taken as a standard with which to measure the eligibility of other roads not included in the survey. As specifically provided by the act, preference will be given to those roads, qualifying as main roads in view of the density of the traffic they serve, which are now included in the Federal-aid system or which will serve as desirable extensions of that system as at present designated.

Reasonable application of the act would seem to be confined to roads of the Federal-aid and State highway systems; to those that the States have authority to take over as parts of the State systems or will obtain authority to take over as enlargements of the main road system; to roads in Indian or other reservations under the Department of the Interior, which the Secretary of the Interior, the Secretary of Agriculture, and the respective State highway departments consider as desirable additions to the main roads system; and to a possible limited mileage of roads in Federal reservations, other than national forests, and not under the control of the Department of the Interior.

As in many places the unappropriated and unreserved public lands are not continuous over a large area, it is anticipated that roads qualifying as "main roads" and selected for improvement under this act may pass alternately through public and private land. In such cases it seems clear that the authority granted to the Federal Government to pay the entire cost of improvement extends only to those parts of such roads that actually lie within publicly owned land.

FEDERAL FUNDS APPORTIONED AND OBLIGATED

The appropriation authorized for the fiscal year 1930 was \$75,000,000, the same amount that has been authorized for each year since 1925. This sum, less 2½ per cent deducted for Federal administration and highway research, was apportioned among the several States and the Territory of Hawaii on December 29, 1928; and the amount credited to each State is shown in Table 36.

As contemplated by the provision of the law which requires the apportionment of the funds authorized for each fiscal year at least six months before the beginning of the fiscal year, a portion of the 1930 funds was obligated before the beginning of the year, and there remained at that time an unobligated balance of only \$56,339,874.64.

The original authorization for the fiscal year 1931 was also \$75,000,000, and the \$73,125,000 of this sum remaining after deduction of the administrative percentage was apportioned on December 2,

1929. This entire amount was available for allotment to new projects immediately upon its apportionment; but if there had been no further authorization, only so much of it as would provide for an uninterrupted program at the rate set by the \$75,000,000 appropriations, would have been allotted during the remainder of the fiscal year, and the year would have ended with an unobligated balance approximately equal to that which remained at the end of the preceding year. This would have entailed the allotment of about \$17,000,000 during the months from January to June, inclusive, leaving the balance of approximately \$56,000,000 to be obligated to new projects between July 1, 1930, and the date of the next apportionment, which normally would have been in December, 1930.

That this does not approximately express the result of the year's activity is due to the fact that Congress, in the act approved April 4, 1930, authorized an additional appropriation of \$50,000,000 for the fiscal year 1931, raising the total authorized for that year to \$125,000,000; and this additional sum, immediately apportioned, was also available for allotment to projects immediately. By this act, which also authorized appropriations of \$125,000,000 for the fiscal years 1932 and 1933, Congress provided for a program at the higher rate, and the States proceeded immediately to adjust their plans to the increased rate. Although only three months of the fiscal year remained, the results show that this adjustment was very promptly begun, for instead of obligating approximately \$73,000,000, as would otherwise have been the case, the amount obligated during the fiscal year reached \$102,498,083.84, which was more than \$32,000,000 greater than the obligations during the preceding fiscal year and the greatest amount thus far obligated in any year.

It was pointed out in the last annual report that the unobligated balance of funds authorized for previous years had been absorbed and that, for the first time since 1923, the funds obligated during the fiscal year 1929 were within the sum apportioned for the year. It was stated that, although the expenditure of \$82,097,380.38 was considerably in excess of the rate of authorization, and although this condition might be expected to exist for a year or two longer, since there is a normal interval of from one to two years between obligation and expenditure of the money, the point had by that time definitely been reached at which, unless there were immediate increase in the appropriations authorized the rate of construction of Federal-aid roads maintained for several years past would be curtailed.

During the fiscal year 1930 the expenditure of \$75,880,862.84, although more than \$6,000,000 less than the previous year's expenditure, was still slightly greater than the funds apportioned for the year. It may be expected that the large increase in funds obligated, as shown by Table 23, will result in a considerable increase in the expenditure next year; but the annual expenditures will not reach the rate fixed by the new authorizations of \$125,000,000 for at least two years and perhaps longer.

TABLE 23.—*Federal-aid funds apportioned to the States and obligated by them for the fiscal years 1923 to 1930, inclusive*

Fiscal year	Apportioned amount of appropriation authorized for the year	Amount of Federal-aid funds obligated during the year	Fiscal year	Apportioned amount of appropriation authorized for the year	Amount of Federal-aid funds obligated during the year
1923-----	\$48,750,000	\$77,461,559	1929-----	\$73,125,000	\$70,428,896
1924-----	63,375,000	89,866,864	1930-----	73,125,000	¹ 102,498,084
1925-----	73,125,000	87,294,396			
1926-----	73,125,000	79,608,897	Total-----	550,875,000	673,533,927
1927-----	73,125,000	77,453,046	Average-----	68,859,375	84,191,741
1928-----	73,125,000	88,922,185			

¹ The sharp increase represented by this amount is due to the obligation of a considerable portion of the enlarged apportionment for the fiscal year 1931.

Although the balance of all apportionments, including that for the fiscal year 1931, unobligated at the close of the fiscal year 1930 was only \$75,716,790.80, from which it would appear that the entire apportionment for 1930 and previous years had been absorbed and \$46,158,209.20 of the apportionment of \$121,875,000 for 1931 in addition, this does not represent the true situation. As a matter of fact, 1 State—Vermont—had already obligated the entire amount of its apportionment of the 1931 authorization; 2 others—Iowa and Maryland—had unobligated balances of the most recent apportionment that could be absorbed on a mile of road; and 37 other States, making a total of 40, had begun to obligate their 1931 apportionments and had drawn more or less deeply on these credits. Of the remaining 8 States, 7—Alabama, Arizona, Florida, Maine, Massachusetts, Montana, and New York—still had not obligated the entire amount of their 1930 apportionments, and 1—Mississippi—had a small balance of its 1929 apportionment and the entire apportionment for 1930 still unobligated.

The Territory of Hawaii, which receives the minimum apportionment of 0.5 per cent of the amount available annually for apportionment, had failed by June 30, 1930, to expend \$326,864.96 of the amount apportioned to it for the fiscal year 1928. As the law provides that the amounts apportioned for each fiscal year must be expended by the end of the second succeeding fiscal year, and that balances not expended with the prescribed period must be reapportioned among all the States, Hawaii loses the above amount, which will be immediately reapportioned among all the States and the Territory in accordance with the rule established for original apportionment.

COST OF THE ROADS

The total cost of the 7,317.4 miles of initial construction and the 2,011.2 miles of stage construction completed during the year was \$193,648,148.64, of which the Federal Government paid \$82,158,756.79, or 42 per cent, and the States the balance. These expenditures were made over the period required to construct the roads, between one and two years. During the same period there were additional expenditures for other projects under construction and not yet completed.

The Federal funds disbursed during the year on all projects active during the period amounted to \$75,880,862.84, as shown in Table 36. This was \$6,216,517 less than the expenditures of the previous year, but still slightly above the rate set by the annual appropriation of \$75,000,000.

The largest disbursements during the year were made to California, Missouri, New York, Pennsylvania, Texas, and Wisconsin. To each of these States the Federal Government paid more than \$3,000,000. All other States received less than that amount.

SUMMARY OF FEDERAL-AID ROAD WORK, BY STATES

The progress made in each of the States during the year and the results of the 14 years of Federal-aid road construction are reported in the following condensed summary for each State.

ALABAMA

The Federal-aid highway system includes 3,884 miles, of which 2,153.8 miles have been improved with Federal aid. Of the improved mileage, 194.2 miles were added during the year. At the close of the year 105.4 miles were under construction.

The mileage improved with Federal aid consists of 259.7 miles of graded and drained earth roads, 523.2 miles of untreated sand-clay, 940.1 miles of untreated gravel, 4.4 miles of treated gravel, 20.8 miles of treated macadam, 62.8 miles of bituminous macadam, 104.3 miles of bituminous concrete, and 228.6 miles of Portland cement concrete, in addition to which there are bridges and approaches with a total length of 9.9 miles.

The total cost of all Federal-aid roads completed during the year, including 14.5 miles of stage construction, was \$3,073,848.12, of which the Federal share was \$1,443,082.40. The disbursement of Federal funds to the State was \$1,092,685.93. The unobligated balance available on June 30, 1930, of all appropriations authorized and apportioned up to that date was \$4,083,610.18.

ARIZONA

The Federal-aid highway system includes 1,979 miles, of which 810.3 miles have been improved with Federal aid. Of the improved mileage, 43.1 miles were added during the year. At the close of the year 285.6 miles were under construction.

The mileage improved with Federal aid consists of 80.2 miles of graded and drained earth roads, 58.8 miles of untreated sand-clay, 462 miles of untreated gravel, 55.8 miles of low-cost bituminous-mixed surface, 38.1 miles of bituminous concrete, and 109.3 miles of Portland cement concrete, in addition to which there are bridges and approaches with a total length of 6.1 miles.

The total cost of all Federal-aid roads completed during the year including 46.6 miles of stage construction, was \$1,535,443.88, of which the Federal share was \$1,379,714.19. The disbursement of Federal funds to the State was \$1,560,058.27. The unobligated balance available on June 30, 1930, of all appropriations authorized and apportioned up to that date was \$1,898,927.83.

ARKANSAS

The Federal-aid highway system includes 5,019 miles, of which 1,741.4 miles have been improved with Federal aid. Of the improved mileage 102.6 miles were added during the year. At the close of the year, 189.1 miles were under construction and 86.4 miles had been approved.

The mileage improved with Federal aid consists of 86.3 miles of graded and drained earth roads, 1,029.4 miles of untreated gravel, 6.4 miles of treated gravel, 41.5 miles of untreated macadam, 110.6 miles of treated macadam, 257.9 miles of bituminous concrete, and 197.4 miles of Portland cement concrete, in addition to which there are bridges and approaches with a total length of 11.9 miles.

The total cost of all Federal-aid roads completed during the year, including 14.3 miles of stage construction, was \$3,401,174.82, of which the Federal share was \$1,685,445.48. The disbursement of Federal funds to the State was \$650,764.79. The unobligated balance available on June 30, 1930, of all appropriations authorized and apportioned up to that date was \$1,518,012.42.

CALIFORNIA

The Federal-aid highway system includes 4,889 miles, of which 1,880.2 miles have been improved with Federal aid. Of the improved mileage, 335.6 miles were added during the year. At the close of the year, 147.2 miles were under construction and 36.1 miles had been approved.

The mileage improved with Federal aid consists of 382.5 miles of graded and drained earth roads, 468.7 miles of untreated gravel, 22.5 miles of untreated macadam, 133.6 miles of low-cost bituminous-mixed surface, 96.8 miles of bituminous macadam, 174.7 miles of bituminous concrete, and 590.8 miles of Portland cement concrete, in addition to which there are bridges and approaches with a total length of 10.6 miles.

The total cost of all Federal-aid roads completed during the year, including 20 miles of stage construction, was \$11,396,353.24, of which the Federal share was \$5,087,674.79. The disbursement of Federal funds to the State was \$3,931,822.91. The unobligated balance available on June 30, 1930, of all appropriations authorized and apportioned up to that date was \$1,743,512.14.

COLORADO

The Federal-aid highway system includes 3,332 miles, of which 1,208.1 miles have been improved with Federal aid. Of the improved mileage, 72.3 miles were added during the year. At the close of the year 221.9 miles were under construction, and 29 miles had been approved.

The mileage improved with Federal aid consists of 200.5 miles of graded and drained earth roads, 67.1 miles of untreated sand-clay, 458.7 miles of untreated gravel, 101.2 miles of untreated macadam, 47.7 miles of low-cost bituminous-mixed surface, 13.1 miles of bituminous concrete, and 306.1 miles of Portland cement concrete, in addition to which there are bridges and approaches with a total length of 13.7 miles.

The total cost of all Federal-aid roads completed during the year, including 38.1 miles of stage construction, was \$1,883,264.93, of which the Federal share was \$994,769.96. The disbursement of Federal funds to the State was \$1,402,520.46. The unobligated balance available on June 30, 1930, of all appropriations authorized and apportioned up to that date was \$2,283,553.54.

CONNECTICUT

The Federal-aid highway system includes 836 miles, of which 243.3 miles have been improved with Federal aid. Of the improved mileage, 14.1 miles were added during the year. At the close of the year 10.9 miles were under construction, and 7.9 miles had been approved.

The mileage improved with Federal aid consists of 0.2 mile of untreated gravel, 17.2 miles of untreated macadam, 39.7 miles of bituminous macadam, 0.6 mile of bituminous concrete, and 181.6 miles of Portland cement concrete, in addition to which there are bridges and approaches with a total length of 4 miles.

The total cost of all Federal-aid roads completed during the year was \$770,370.16, of which the Federal share was \$255,295.83. The disbursement of Federal funds to the State was \$281,922.76. The unobligated balance available on June 30, 1930, of all appropriations authorized and apportioned up to that date was \$714,247.71.

DELAWARE

The Federal-aid highway system includes 550 miles, of which 251 miles have been improved with Federal aid. Of the improved mileage, 45.2 miles were added during the year. At the close of the year 24.9 miles were under construction and 41.2 miles had been approved.

The mileage improved with Federal aid consists of 11.2 miles of untreated gravel, 11.7 miles of low-cost bituminous-mixed surface, 221.3 miles of Portland cement concrete, and 6.2 miles of block pavement, in addition to which there are bridges and approaches with a total length of 0.6 mile.

The total cost of all Federal-aid roads completed during the year was \$835,954.86, of which the Federal share was \$406,222.78. The disbursement of Federal funds to the State was \$594,597.88. The unobligated balance available on June 30, 1930, of all appropriations authorized and apportioned up to that date was \$91,051.91.

FLORIDA

The Federal-aid highway system includes 1,926 miles, of which 503.5 miles have been improved with Federal aid. Of the improved mileage, 54.3 miles were added during the year. At the close of the year 102.6 miles were under construction.

The mileage improved with Federal aid consists of 14.9 miles of graded and drained earth roads, 15.6 miles of untreated sand-clay, 1 mile of treated gravel, 85.4 miles of untreated macadam, 67 miles of treated macadam, 72.6 miles of bituminous macadam, 60.7 miles of bituminous concrete, 168 miles of Portland cement concrete, and 10.2 miles of block pavement, in addition to which there are bridges and approaches with a total length of 8.1 miles.

The total cost of all Federal-aid roads completed during the year was \$1,381,290.93, of which the Federal share was \$596,942.17. The disbursement of Federal funds to the State was \$660,158.48. The unobligated balance available on June 30, 1930, of all appropriations authorized and apportioned up to that date was \$1,681,203.79.

GEORGIA

The Federal-aid highway system includes 5,554 miles, of which 2,703.3 miles have been improved with Federal aid. Of the improved mileage, 134.5 miles were added during the year. At the close of the year 150.8 miles were under construction, and 59.6 miles had been approved.

The mileage improved with Federal aid consists of 214.7 miles of graded and drained earth roads, 1,129.4 miles of untreated sand-clay, 441 miles of untreated gravel, 3.7 miles of treated gravel, 52.3 miles of untreated macadam, 88.5 miles of treated macadam, 207.3 miles of bituminous macadam, 54.2 miles of bituminous concrete, 481.5 miles of Portland cement concrete, and 0.5 mile of block pavement, in addition to which there are bridges and approaches with a total length of 30.2 miles.

The total cost of all Federal-aid roads completed during the year, including 41.4 miles of stage construction, was \$2,910,553.68, of which the Federal share was \$1,230,736.17. The disbursement of Federal funds to the State was \$623,085.28. The unobligated balance available on June 30, 1930, of all appropriations authorized and apportioned up to that date was \$2,902,272.18.

IDAHO

The Federal-aid highway system includes 3,116 miles, of which 1,194.1 miles have been improved with Federal aid. Of the improved mileage, 77.1 miles were added during the year. At the close of the year 113 miles were under construction, and 54.3 miles had been approved.

The mileage improved with Federal aid consists of 180.8 miles of graded and drained earth roads, 582.3 miles of untreated gravel, 244.1 miles of untreated macadam, 28.5 miles of low-cost bituminous-mixed surface, 20.4 miles of bituminous macadam, 89.7 miles of bituminous concrete, and 44.6 miles of Portland cement concrete, in addition to which there are bridges and approaches with a total length of 3.7 miles.

The total cost of all Federal-aid roads completed during the year was \$937,768.62, of which the Federal share was \$565,258.96. The disbursement of Federal funds to the State was \$574,315.68. The unobligated balance available on June 30, 1930, of all appropriations authorized and apportioned up to that date was \$1,175,024.06.

ILLINOIS

The Federal-aid highway system includes 6,650 miles, of which 2,056.1 miles have been improved with Federal aid. Of the improved mileage, 169 miles were added during the year. At the close of the year 454.4 miles were under construction, and 153.9 miles had been approved.

The mileage improved with Federal aid consists of 183.9 miles of graded and drained earth roads, 0.4 mile of untreated gravel, 3.3 miles of bituminous macadam, 8.1 miles of bituminous concrete, 1,832.8 miles of Portland cement concrete, and 25.4 miles of block pavement, in addition to which there are bridges and approaches with a total length of 2.2 miles.

The total cost of all Federal-aid roads completed during the year was \$5,021,954.42, of which the Federal share was \$2,201,666.48. The disbursement of Federal funds to the State was \$1,908,477.62. The unobligated balance available on June 30, 1930, of all appropriations authorized and apportioned up to that date was \$4,656,255.25.

INDIANA

The Federal-aid highway system includes 4,694 miles, of which 1,481.6 miles have been improved with Federal aid. Of the improved mileage, 214.7 miles were added during the year. At the close of the year 153.2 miles were under construction, and 9.9 miles had been approved.

The mileage improved with Federal aid consists of 16.9 miles of graded and drained earth roads, 90.2 miles of untreated gravel, 17 miles of bituminous macadam, 12 miles of bituminous concrete, 1,334.8 miles of Portland cement concrete, and 6.6 miles of block pavement, in addition to which there are bridges and approaches with a total length of 4.1 miles.

The total cost of all Federal-aid roads completed during the year was \$6,693,965.53, of which the Federal share was \$3,142,358.52. The disbursement of Federal funds to the State was \$2,295,345.32. The unobligated balance available on June 30, 1930, of all appropriations authorized and apportioned up to that date was \$2,473,551.58.

IOWA

The Federal-aid highway system includes 7,212 miles, of which 2,979.7 miles have been improved with Federal aid. Of the improved mileage, 66.8 miles were added during the year. At the close of the year 242.9 miles were under construction, and 11.8 miles had been approved.

The mileage improved with Federal aid consists of 1,201.5 miles of graded and drained earth roads, 521.1 miles of untreated gravel, 1,233.1 miles of Portland cement concrete, and 21.9 miles of block pavement, in addition to which there are bridges and approaches with a total length of 2.1 miles.

The total cost of all Federal-aid roads completed during the year, including 146.6 miles of stage construction, was \$5,075,345.20, of which the Federal share was \$2,411,131.90. The disbursement of Federal funds to the State was \$2,504,338.70. The unobligated balance available on June 30, 1930, of all appropriations authorized and apportioned up to that date was \$1,892.77.

KANSAS

The Federal-aid highway system includes 7,917 miles, of which 2,833.9 miles have been improved with Federal aid. Of the improved mileage, 324.3 miles were added during the year. At the close of the

year 276.5 miles were under construction, and 20.6 miles had been approved.

The mileage improved with Federal aid consists of 1,277.5 miles of graded and drained earth roads, 276.6 miles of untreated sand-clay, 239.7 miles of untreated gravel, 4.5 miles of untreated macadam, 129.9 miles of bituminous macadam, 3.5 miles of bituminous concrete, 722.2 miles of Portland cement concrete, and 166 miles of block pavement, in addition to which there are bridges and approaches with a total length of 14 miles.

The total cost of all Federal-aid roads completed during the year, including 16.9 miles of stage construction, was \$4,022,635.69, of which the Federal share was \$1,838,127.19. The disbursement of Federal funds to the State was \$2,541,954.83. The unobligated balance available on June 30, 1930, of all appropriations authorized and apportioned up to that date was \$2,063,112.86.

KENTUCKY

The Federal-aid highway system includes 3,710 miles, of which 1,530.2 miles have been improved with Federal aid. Of the improved mileage, 218.9 miles were added during the year. At the close of the year 127.1 miles were under construction, and 50.5 miles had been approved.

The mileage improved with Federal aid consists of 682 miles of graded and drained earth roads, 390 miles of untreated gravel, 20.4 miles of untreated macadam, 50.3 miles of treated macadam, 84.3 miles of bituminous macadam, 115.2 miles of bituminous concrete, 180.1 miles of Portland-cement concrete, and 3.9 miles of block pavement, in addition to which there are bridges and approaches with a total length of 4 miles.

The total cost of all Federal-aid roads completed during the year, including 35.3 miles of stage construction, was \$3,182,683.33, of which the Federal share was \$1,522,746.58. The disbursement of Federal funds to the State was \$1,537,194.33. The unobligated balance available on June 30, 1930, of all appropriations authorized and apportioned up to that date, was \$114,878.62.

LOUISIANA

The Federal-aid highway system includes 2,713 miles, of which 1,352.4 miles have been improved with Federal aid. Of the improved mileage, 46.7 miles were added during the year. At the close of the year 168.1 miles were under construction, and 49 miles had been approved.

The mileage improved with Federal aid consists of 35.1 miles of graded and drained earth roads, 1,219.8 miles of untreated gravel, 3.2 miles of bituminous macadam, 43 miles of bituminous concrete, and 39.8 miles of Portland-cement concrete, in addition to which there are bridges and approaches with a total length of 11.5 miles.

The total cost of all Federal-aid roads completed during the year, including 7.5 miles of reconstruction, was \$739,997.12, of which the Federal share was \$330,765.30. The disbursement of Federal funds to the State was \$852,639.40. The unobligated balance available on June 30, 1930, of all appropriations authorized and apportioned up to that date, was \$1,224,288.48.

MAINE

The Federal-aid highway system includes 1,579 miles, of which 534.8 miles have been improved with Federal aid. Of the improved mileage, 54.3 miles were added during the year. At the close of the year 57.6 miles were under construction, and 23.9 miles had been approved.

The mileage improved with Federal aid consists of 222.8 miles of untreated gravel, 28.3 miles of treated gravel, 175.3 miles of bituminous macadam, and 107.8 miles of Portland cement concrete, in addition to which there are bridges and approaches with a total length of 0.6 mile.

The total cost of all Federal-aid roads completed during the year, including 1.9 miles of reconstruction, was \$1,990,485.62, of which the Federal share was \$713,957.89. The disbursement of Federal funds to the State was \$1,187,526.36. The unobligated balance available on June 30, 1930, of all appropriations authorized and apportioned up to that date was \$1,354,501.03.

MARYLAND

The Federal-aid highway system includes 1,705 miles, of which 630.7 miles have been improved with Federal aid. Of the improved mileage, 34.1 miles were added during the year. At the close of the year 47.4 miles were under construction, and 26 miles had been approved.

The mileage improved with Federal aid consists of 4.7 miles of graded and drained earth roads, 31.5 miles of untreated gravel, 0.1 mile of untreated macadam, 3.9 miles of treated macadam, 224.9 miles of bituminous macadam, 31.5 miles of bituminous concrete, and 334.1 miles of Portland cement concrete.

The total cost of all Federal-aid roads completed during the year, including 14.7 miles of stage construction, and 3 miles of reconstruction, was \$1,084,004.76, of which the Federal share was \$502,002.20. The disbursement of Federal funds to the State was \$466,652.87. The unobligated balance available on June 30, 1930, of all appropriations authorized and apportioned up to that date was \$5,543.03.

MASSACHUSETTS

The Federal-aid highway system includes 1,343 miles, of which 657.4 miles have been improved with Federal aid. Of the improved mileage, 89.6 miles were added during the year. At the close of the year 68.6 miles were under construction, and 11.3 miles had been approved.

The mileage improved with Federal aid consists of 0.5 mile of untreated gravel, 0.4 mile of treated gravel, 0.1 mile of untreated macadam, 2.8 miles of treated macadam, 22 miles of low-cost bituminous-mixed surface, 366.2 miles of bituminous macadam, 56.4 miles of bituminous concrete, and 204.4 miles of Portland cement concrete, in addition to which there are bridges and approaches with a total length of 4.6 miles.

The total cost of all Federal-aid roads completed during the year, including 0.7 mile of stage construction and 2.7 miles of reconstruction, was \$4,416,602.77, of which the Federal share was

\$1,468,754.17. The disbursement of Federal funds to the State was \$1,546,517.25. The unobligated balance available on June 30, 1930, of all appropriations authorized and apportioned up to that date was \$1,944,255.39.

MICHIGAN

The Federal-aid highway system includes 5,238 miles, of which 1,605.2 miles have been improved with Federal aid. Of the improved mileage, 172.4 miles were added during the year. At the close of the year 261 miles were under construction, and 30.1 miles had been approved.

The mileage improved with Federal aid consists of 8.6 miles of graded and drained earth roads, 342.7 miles of untreated gravel, 16.3 miles of treated macadam, 10.4 miles of bituminous macadam, 69 miles of bituminous concrete, 1,155.4 miles of Portland cement concrete, and 0.4 mile of block pavement, in addition to which there are bridges and approaches with a total length of 2.4 miles.

The total cost of all Federal-aid roads completed during the year, including 2.9 miles of stage construction, was \$7,779,534.69, of which the Federal share was \$3,020,745.34. The disbursement of Federal funds to the State was \$2,300,913.73. The unobligated balance available on June 30, 1930, of all appropriations authorized and apportioned up to that date was \$2,782,145.14.

MINNESOTA

The Federal-aid highway system includes 6,885 miles, of which 3,936.1 miles have been improved with Federal aid. Of the improved mileage, 242.5 miles were added during the year. At the close of the year 469.7 miles were under construction and 19.4 miles had been approved.

The mileage improved with Federal aid consists of 1,000.6 miles of graded and drained earth roads, 11.1 miles of untreated sand-clay, 2,079 miles of untreated gravel, 17.6 miles of treated gravel, 32.7 miles of bituminous concrete, and 793.5 miles of Portland cement concrete, in addition to which there are bridges and approaches with a total length of 1.6 miles.

The total cost of all Federal-aid roads completed during the year, including 82.8 miles of stage construction, was \$4,573,620.24, of which the Federal share was \$1,786,351.44. The disbursement of Federal funds to the State was \$2,192,899.80. The unobligated balance available on June 30, 1930, of all appropriations authorized and apportioned up to that date was \$46,352.03.

MISSISSIPPI

The Federal-aid highway system includes 3,632 miles, of which 1,820.7 miles have been improved with Federal aid. Of the improved mileage, 155.2 miles were added during the year. At the close of the year 62.7 miles were under construction and 0.1 mile had been approved.

The mileage improved with Federal aid consists of 294.6 miles of graded and drained earth roads, 15.8 miles of untreated sand-clay, 1,220.6 miles of untreated gravel, 11.1 miles of untreated macadam,

12.4 miles of bituminous concrete, 246.3 miles of Portland cement concrete, and 9.7 miles of block pavement, in addition to which there are bridges and approaches with a total length of 10.2 miles.

The total cost of all Federal-aid roads completed during the year, including 4.4 miles of stage construction, was \$3,178,703.45, of which the Federal share was \$1,550,795.82. The disbursement of Federal funds to the State was \$745,258.17. The unobligated balance available on June 30, 1930, of all appropriations authorized and apportioned up to that date was \$3,527,955.68.

MISSOURI

The Federal-aid highway system includes 7,530 miles, of which 2,486.8 miles have been improved with Federal aid. Of the improved mileage, 217 miles were added during the year. At the close of the year 178.8 miles were under construction, and 61.6 miles had been approved.

The mileage improved with Federal aid consists of 392.3 miles of graded and drained earth roads, 752.8 miles of untreated gravel, 27.2 miles of untreated macadam, 43 miles of bituminous macadam, 20.1 miles of bituminous concrete, 1,220.1 miles of Portland cement concrete, and 20.9 miles of block pavement, in addition to which there are bridges and approaches with a total length of 10.4 miles.

The total cost of all Federal-aid roads completed during the year, including 138.8 miles of stage construction, was \$10,177,544.47, of which the Federal share was \$4,125,021.08. The disbursement of Federal funds to the State was \$3,436,554.13. The unobligated balance available on June 30, 1930, of all appropriations authorized and apportioned up to that date was \$831,704.84.

MONTANA

The Federal-aid highway system includes 5,108 miles, of which 1,717.4 miles have been improved with Federal aid. Of the improved mileage, 214.1 miles were added during the year. At the close of the year 569.6 miles were under construction, and 90.2 miles had been approved.

The mileage improved with Federal aid consists of 210.2 miles of graded and drained earth roads, 1,442.9 miles of untreated gravel, 8.8 miles of low-cost bituminous-mixed surface, 12.5 miles of bituminous concrete, and 37 miles of Portland cement concrete, in addition to which there are bridges and approaches with a total length of 6 miles.

The total cost of all Federal-aid roads completed during the year, including 4.1 miles of stage construction, was \$2,557,945.61, of which the Federal share was \$1,565,807.28. The disbursement of Federal funds to the State was \$2,571,899.09. The unobligated balance available on June 30, 1930, of all appropriations authorized and apportioned up to that date was \$3,540,456.15.

NEBRASKA

The Federal-aid highway system includes 5,530 miles, of which 3,669.1 miles have been improved with Federal aid. Of the improved mileage, 137.8 miles were added during the year. At the

close of the year 418.8 miles were under construction, and 54.7 miles had been approved.

The mileage improved with Federal aid consists of 504.6 miles of graded and drained earth roads, 3,027.1 miles of untreated sand-clay, 0.8 mile of treated sand-clay, 3.8 miles of low-cost bituminous-mixed surface, 14.6 miles of bituminous concrete, 90.1 miles of Portland cement concrete, and 19.6 miles of block pavement, in addition to which there are bridges and approaches with a total length of 8.5 miles.

The total cost of all Federal-aid roads completed during the year, including 161.4 miles of stage construction, was \$2,280,225.35, of which the Federal share was \$1,078,362.13. The disbursement of Federal funds to the State was \$1,980,717.15. The unobligated balance available on June 30, 1930, of all appropriations authorized and apportioned up to that date was \$2,176,337.14.

NEVADA

The Federal-aid highway system includes 1,565 miles, of which 1,219.2 miles have been improved with Federal aid. Of the improved mileage, 147.3 miles were added during the year. At the close of the year 122.1 miles were under construction.

The mileage improved with Federal aid consists of 46.8 miles of graded and drained earth roads, 805.1 miles of untreated gravel, 14.3 miles of treated gravel, 282.5 miles of low-cost bituminous-mixed surface, 20.6 miles of bituminous macadam, 1.9 miles of bituminous concrete, and 45.2 miles of Portland cement concrete, in addition to which there are bridges and approaches with a total length of 2.8 miles.

The total cost of all Federal-aid roads completed during the year, including 191.9 miles of stage construction, was \$1,494,392.50, of which the Federal share was \$1,312,039.17. The disbursement of Federal funds to the State was \$996,033.53. The unobligated balance available on June 30, 1930, of all appropriations authorized and apportioned up to that date was \$773,969.02.

NEW HAMPSHIRE

The Federal-aid highway system includes 991 miles, of which 352.7 miles have been improved with Federal aid. Of the improved mileage, 19 miles were added during the year. At the close of the year 36.6 miles were under construction.

The mileage improved with Federal aid consists of 97.5 miles of untreated macadam, 74.8 miles of treated macadam, 86.1 miles of bituminous macadam, 35.9 miles of bituminous concrete, and 54.5 miles of Portland cement concrete, in addition to which there are bridges and approaches with a total length of 3.9 miles.

The total cost of all Federal-aid roads completed during the year, including 1 mile of stage construction and 2.1 miles of reconstruction, was \$833,461.61, of which the Federal share was \$319,996.37. The disbursement of Federal funds to the State was \$464,211.66. The unobligated balance available on June 30, 1930, of all appropriations authorized and apportioned up to that date was \$221,369.45.

NEW JERSEY

The Federal-aid highway system includes 1,186 miles, of which 507.8 miles have been improved with Federal aid. Of the improved mileage, 45.1 miles were added during the year. At the close of the year 66.7 miles were under construction.

The mileage improved with Federal aid consists of 11.8 miles of graded and drained earth roads, 6 miles of untreated gravel, 0.2 mile of treated macadam, 0.5 mile of bituminous macadam, 22.5 miles of bituminous concrete, and 464.4 miles of Portland cement concrete, in addition to which there are bridges and approaches with a total length of 2.4 miles.

The total cost of all Federal-aid roads completed during the year was \$3,757,925.87, of which the Federal share was \$677,880. The disbursement of Federal funds to the State was \$629,055. The unobligated balance available on June 30, 1930, of all appropriations authorized and apportioned up to that date was \$977,248.76.

NEW MEXICO

The Federal-aid highway system includes 3,466 miles, of which 1,904.4 miles have been improved with Federal aid. Of the improved mileage, 87.5 miles were added during the year. At the close of the year, 236 miles were under construction and 32.6 miles had been approved.

The mileage improved with Federal aid consists of 265.7 miles of graded and drained earth roads, 27.3 miles of untreated sand-clay, 1,506.9 miles of untreated gravel, 17.2 miles of low-cost bituminous-mixed surface, 0.7 mile of bituminous concrete, and 82.5 miles of Portland cement concrete, in addition to which there are bridges and approaches with a total length of 4.1 miles.

The total cost of all Federal-aid roads completed during the year, including 0.7 mile of stage construction, was \$1,331,927.95, of which the Federal share was \$838,102.84. The disbursement of Federal funds to the State was \$827,764.88. The unobligated balance available on June 30, 1930, of all appropriations authorized and apportioned up to that date was \$969,531.76.

NEW YORK

The Federal-aid highway system includes 5,558 miles, of which 2,491 miles have been improved with Federal aid. Of the improved mileage, 306.9 miles were added during the year. At the close of the year, 300.4 miles were under construction and 83.6 miles had been approved.

The mileage improved with Federal aid consists of 46.9 miles of graded and drained earth roads, 76.4 miles of untreated gravel, 402.5 miles of bituminous macadam, 11.5 miles of bituminous concrete, 1,951 miles of Portland cement concrete, and 0.7 mile of block pavement, in addition to which there are bridges and approaches with a total length of 2 miles.

The total cost of all Federal-aid roads completed during the year was \$12,240,775.13, of which the Federal share was \$4,431,341.77. The disbursement of Federal funds to the State was \$4,078,108.85. The unobligated balance available on June 30, 1930, of all appropriations authorized and apportioned up to that date was \$7,315,347.86.

NORTH CAROLINA

The Federal-aid highway system includes 4,219 miles, of which 1,780.6 miles have been improved with Federal aid. Of the improved mileage, 90.8 miles were added during the year. At the close of the year 175.5 miles were under construction, and 25.8 miles had been approved.

The mileage improved with Federal aid consists of 87.9 miles of graded and drained earth roads, 474.6 miles of untreated sand-clay, 78 miles of untreated gravel, 19.6 miles of untreated macadam, 35.6 miles of bituminous macadam, 256.9 miles of bituminous concrete, and 824 miles of Portland cement concrete, in addition to which there are bridges and approaches with a total length of 4 miles.

The total cost of all Federal-aid roads completed during the year, including 9.5 miles of stage construction, was \$1,694,550.53, of which the Federal share was \$798,658.46. The disbursement of Federal funds to the State was \$711,610.60. The unobligated balance available on June 30, 1930, of all appropriations authorized and apportioned up to that date was \$2,560,469.31.

NORTH DAKOTA

The Federal-aid highway system includes 7,424 miles, of which 4,262.6 miles have been improved with Federal aid. Of the improved mileage, 577.2 miles were added during the year. At the close of the year 468.3 miles were under construction, and 151.3 miles had been approved.

The mileage improved with Federal aid consists of 1,375.8 miles of graded and drained earth roads, 10.8 miles of untreated sand-clay, 2,779.8 miles of untreated gravel, 80.6 miles of treated gravel, 1.1 miles of bituminous concrete, and 6.6 miles of Portland-cement concrete, in addition to which there are bridges and approaches with a total length of 7.9 miles.

The total cost of all Federal-aid roads completed during the year, including 392.5 miles of stage construction, was \$3,931,493.45, of which the Federal share was \$1,630,756.04. The disbursement of Federal funds to the State was \$1,236,250.08. The unobligated balance available on June 30, 1930, of all appropriations authorized and apportioned up to that date was \$1,452,524.56.

OHIO

The Federal-aid highway system includes 5,899 miles, of which 2,190.4 miles have been improved with Federal aid. Of the improved mileage, 217.8 miles were added during the year. At the close of the year 403 miles were under construction and 83.1 miles had been approved.

The mileage improved with Federal aid consists of 120.6 miles of graded and drained earth roads, 9.4 miles of untreated gravel, 110.7 miles of untreated macadam, 26.1 miles of treated macadam, 356.5 miles of bituminous macadam, 156.1 miles of bituminous concrete, 883.8 miles of Portland cement concrete, and 522.7 miles of block pavement, in addition to which there are bridges and approaches with a total length of 4.5 miles.

The total cost of all Federal-aid roads completed during the year was \$7,966,093.72, of which the Federal share was \$3,298,783.47. The disbursement of Federal funds to the State was \$2,455,602.56. The unobligated balance available on June 30, 1930, of all appropriations authorized and apportioned up to that date was \$939,205.53.

OKLAHOMA

The Federal-aid highway system includes 5,622 miles, of which 1,890.4 miles have been improved with Federal aid. Of the improved mileage, 119.3 miles were added during the year. At the close of the year 172.6 miles were under construction and 92.7 miles had been approved.

The mileage improved with Federal aid consists of 378.5 miles of graded and drained earth roads, 0.7 mile of untreated sand-clay, 559.2 miles of untreated gravel, 8.3 miles of treated gravel, 28.8 miles of untreated macadam, 0.5 mile of bituminous macadam, 151 miles of bituminous concrete, 741.1 miles of Portland cement concrete, and 8.9 miles of block pavement, in addition to which there are bridges and approaches with a total length of 13.4 miles.

The total cost of all Federal-aid roads completed during the year, including 59.1 miles of stage construction, was \$3,764,985.03, of which the Federal share was \$1,697,687.86. The disbursement of Federal funds to the State was \$2,080,335.52. The unobligated balance available on June 30, 1930, of all appropriations authorized and apportioned up to that date was \$184,302.92.

OREGON

The Federal-aid highway system includes 3,247 miles, of which 1,150.4 miles have been improved with Federal aid. Of the improved mileage, 87.9 miles were added during the year. At the close of the year 289.9 miles were under construction, and 49.1 miles had been approved.

The mileage improved with Federal aid consists of 235.3 miles of graded and drained earth roads, 711.5 miles of untreated gravel, 25.6 miles of untreated macadam, 14.2 miles of bituminous macadam, 64.2 miles of bituminous concrete, and 94.7 miles of Portland cement concrete, in addition to which there are bridges and approaches with a total length of 4.9 miles.

The total cost of all Federal-aid roads completed during the year was \$1,129,094.63, of which the Federal share was \$597,022.73. The disbursement of Federal funds to the State was \$703,274.47. The unobligated balance available on June 30, 1930, of all appropriations authorized and apportioned up to that date was \$288,573.31.

PENNSYLVANIA

The Federal-aid highway system includes 5,487 miles, of which 2,341.9 miles have been improved with Federal aid. Of the improved mileage, 274.3 miles were added during the year. At the close of the year 225.8 miles were under construction, and 87.1 miles had been approved.

The mileage improved with Federal aid consists of 156.9 miles of graded and drained earth roads, 10.6 miles of treated macadam,

7.7 miles of bituminous macadm, 98.4 miles of bituminous concrete, 2,026.8 miles of Portland cement concrete, and 39.5 miles of block pavement, in addition to which there are bridges and approaches with a total length of 2 miles.

The total cost of all Federal-aid roads completed during the year was \$15,902,008.93, of which the Federal share was \$4,439,697.96. The disbursement of Federal funds to the State was \$3,710,013.31. The unobligated balance available on June 30, 1930, of all appropriations authorized and apportioned up to that date was \$1,082,376.94.

RHODE ISLAND

The Federal-aid highway system includes 417 miles, of which 184.7 miles have been improved with Federal aid. Of the improved mileage, 19.5 miles were added during the year. At the close of the year 28.2 miles were under construction.

The mileage improved with Federal aid consists of 1.8 miles of treated macadam, 57.1 miles of bituminous macadam, 48.1 miles of bituminous concrete, and 76.8 miles of Portland cement concrete, in addition to which there are bridges and approaches with a total length of 0.9 mile.

The total cost of all Federal-aid roads completed during the year was \$910,987.88, of which the Federal share was \$326,666.13. The disbursement of Federal funds to the State was \$171,477.02. The unobligated balance available on June 30, 1930, of all appropriations authorized and apportioned up to that date was \$588,570.42.

SOUTH CAROLINA

The Federal-aid highway system includes 3,232 miles, of which 1,868.5 miles have been improved with Federal aid. Of the improved mileage, 98.9 miles were added during the year. At the close of the year 178.6 miles were under construction, and 27.2 miles had been approved.

The mileage improved with Federal aid consists of 43.3 miles of graded and drained earth roads, 1,202 miles of untreated sand-clay, 107.7 miles of untreated gravel, 3.1 miles of bituminous macadam, 186 miles of bituminous concrete, and 303.7 miles of Portland cement concrete, in addition to which there are bridges and approaches with a total length of 22.7 miles.

The total cost of all Federal-aid roads completed during the year, including 45 miles of stage construction, was \$3,511,295.63, of which the Federal share was \$1,016,308.31. The disbursement of Federal funds to the State was \$926,038.22. The unobligated balance available on June 30, 1930, of all appropriations authorized and apportioned up to that date was \$97,283.99.

SOUTH DAKOTA

The Federal-aid highway system includes 6,148 miles, of which 3,445.1 miles have been improved with Federal aid. Of the improved mileage, 243.1 miles were added during the year. At the close of the year 596.1 miles were under construction, and 44 miles had been approved.

The mileage improved with Federal aid consists of 204.5 miles of graded and drained earth roads, 36 miles of untreated sand-clay, 15.7 miles of treated sand-clay, 3,162.6 miles of untreated gravel, 9.5 miles of low-cost bituminous-mixed surface, and 12.9 miles of Portland cement concrete, in addition to which there are bridges and approaches with a total length of 3.9 miles.

The total cost of all Federal-aid roads completed during the year, including 42.2 miles of stage construction, was \$1,594,466.64, of which the Federal share was \$852,372.53. The disbursement of Federal funds to the State was \$1,162,383.12. The unobligated balance available on June 30, 1930, of all appropriations authorized and apportioned up to that date was \$1,062,892.43.

TENNESSEE

The Federal-aid highway system includes 3,521 miles, of which 1,260.9 miles have been improved with Federal aid. Of the improved mileage, 125.2 miles were added during the year. At the close of the year 144.8 miles were under construction, and 82.3 miles had been approved.

The mileage improved with Federal aid consists of 104.7 miles of graded and drained earth roads, 106.3 miles of untreated gravel, 61.5 miles of untreated macadam, 361.7 miles of bituminous macadam, 121.6 miles of bituminous concrete, and 497.9 miles of Portland cement concrete, in addition to which there are bridges and approaches with a total length of 7.2 miles.

The total cost of all Federal-aid roads completed during the year was \$3,088,719.17, of which the Federal share was \$1,443,055.24. The disbursement of Federal funds to the State was \$1,459,546.34. The unobligated balance available on June 30, 1930, of all appropriations authorized and apportioned up to that date was \$1,552,381.84.

TEXAS

The Federal-aid highway system includes 11,722 miles, of which 6,835.6 miles have been improved with Federal aid. Of the improved mileage, 636 miles were added during the year. At the close of the year 496.1 miles were under construction, and 101.6 miles had been approved.

The mileage improved with Federal aid consists of 835.3 miles of graded and drained earth roads, 39.4 miles of untreated sand-clay, 2,857.6 miles of untreated gravel, 292.2 miles of treated gravel, 72.7 miles of untreated macadam, 119.7 miles of treated macadam, 19.8 miles of low-cost bituminous-mixed surface, 521.8 miles of bituminous macadam, 709.6 miles of bituminous concrete, 1,307.1 miles of Portland cement concrete, and 30.2 miles of block pavement, in addition to which there are bridges and approaches with a total length of 30.2 miles.

The total cost of all Federal-aid roads completed during the year, including 368.1 miles of stage construction, was \$16,492,620.38, of which the Federal share was \$7,347,398.73. The disbursement of Federal funds to the State was \$6,292,484.66. The unobligated balance available on June 30, 1930, of all appropriations authorized and apportioned up to that date was \$4,647,819.57.

UTAH

The Federal-aid highway system includes 1,751 miles, of which 981.2 miles have been improved with Federal aid. Of the improved mileage, 73.7 miles were added during the year. At the close of the year 67.1 miles were under construction and 44.9 miles had been approved.

The mileage improved with Federal aid consists of 110.9 miles of graded and drained earth roads, 146.8 miles of untreated gravel, 3.4 miles of treated gravel, 560.9 miles of untreated macadam, 39.2 miles of low-cost bituminous-mixed surface, 0.8 mile of bituminous macadam, 10.6 miles of bituminous concrete, and 105.9 miles of Portland cement concrete, in addition to which there are bridges and approaches with a total length of 2.7 miles.

The total cost of all Federal-aid roads completed during the year was \$1,754,707.02, of which the Federal share was \$1,138,237.82. The disbursement of Federal funds to the State was \$730,519.47. The unobligated balance available on June 30, 1930, of all appropriations authorized and apportioned up to that date was \$662,833.17.

VERMONT

The Federal-aid highway system includes 1,043 miles, of which 255.6 miles have been improved with Federal aid. Of the improved mileage, 29.4 miles were added during the year. At the close of the year 45.1 miles were under construction, and 5.7 miles had been approved.

The mileage improved with Federal aid consists of 106.6 miles of untreated gravel, 2 miles of treated gravel, 1.2 miles of untreated macadam, 51.6 miles of bituminous macadam, and 89.6 miles of Portland-cement concrete, in addition to which there are bridges and approaches with a total length of 4.6 miles.

The total cost of all Federal-aid roads completed during the year was \$1,465,991.89, of which the Federal share was \$497,157.48. The disbursement of Federal funds to the State was \$366,821.03. All appropriations authorized and apportioned up to June 30, 1930, had been obligated on that date.

VIRGINIA

The Federal-aid highway system includes 3,565 miles, of which 1,467.9 miles have been improved with Federal aid. Of the improved mileage, 137.3 miles were added during the year. At the close of the year 216.7 miles were under construction, and 28 miles had been approved.

The mileage improved with Federal aid consists of 85 miles of graded and drained earth roads, 216.3 miles of untreated sand-clay, 101.3 miles of untreated gravel, 133.8 miles of untreated macadam, 9.4 miles of treated macadam, 374.1 miles of bituminous macadam, 39.8 miles of bituminous concrete, and 502.1 miles of Portland cement concrete, in addition to which there are bridges and approaches with a total length of 6.1 miles.

The total cost of all Federal-aid roads completed during the year, including 21.7 miles of stage construction, was \$3,984,741.95,

of which the Federal share was \$1,627,334.71. The disbursement of Federal funds to the State was \$1,090,622.55. The unobligated balance available on June 30, 1930, of all appropriations authorized and apportioned up to that date was \$691,693.83.

WASHINGTON

The Federal-aid highway system includes 3,033 miles, of which 934.6 miles have been improved with Federal aid. Of the improved mileage, 101.1 miles were added during the year. At the close of the year 126.3 miles were under construction, and 2.1 miles had been approved.

The mileage improved with Federal aid consists of 179.4 miles of graded and drained earth roads, 420.4 miles of untreated gravel, and 329.8 miles of Portland cement concrete, in addition to which there are bridges and approaches with a total length of 5 miles.

The total cost of all Federal-aid roads completed during the year, including 10.4 miles of stage construction, was \$4,176,691.12, of which the Federal share was \$1,493,032.99. The disbursement of Federal funds to the State was \$1,377,438.14. The unobligated balance available on June 30, 1930, of all appropriations authorized and apportioned up to that date was \$1,211,773.29.

WEST VIRGINIA

The Federal-aid highway system includes 2,214 miles, of which 710.1 miles have been improved with Federal aid. Of the improved mileage, 39 miles were added during the year. At the close of the year 102.8 miles were under construction, and 20.5 miles had been approved.

The mileage improved with Federal aid consists of 249.6 miles of graded and drained earth roads, 28.3 miles of untreated gravel, 14.2 miles of untreated macadam, 0.6 mile of treated macadam, 185 miles of bituminous macadam, 28.7 miles of bituminous concrete, 190.2 miles of Portland cement concrete, and 11.4 miles of block pavement, in addition to which there are bridges and approaches with a total length of 2.1 miles.

The total cost of all Federal-aid roads completed during the year, including 17.6 miles of stage construction, was \$1,968,983.06, of which the Federal share was \$744,716.04. The disbursement of Federal funds to the State was \$874,504.14. The unobligated balance available on June 30, 1930, of all appropriations authorized and apportioned up to that date was \$628,588.82.

WISCONSIN

The Federal-aid highway system includes 5,493 miles, of which 2,246.2 miles have been improved with Federal aid. Of the improved mileage, 288.6 miles were added during the year. At the close of the year 245.7 miles were under construction and 28 miles had been approved.

The mileage improved with Federal aid consists of 144.2 miles of graded and drained earth roads, 23.8 miles of untreated sand-clay, 1,030.2 miles of untreated gravel, 19.9 miles of treated gravel, 13.7 miles of bituminous macadam, 0.4 mile of bituminous concrete, and

1,007.1 miles of Portland cement concrete, in addition to which there are bridges and approaches with a total length of 6.9 miles.

The total cost of all Federal-aid roads completed during the year, including 31.7 miles of stage construction, was \$9,029,204.63, of which the Federal share was \$4,154,568.49. The disbursement of Federal funds to the State was \$3,058,505.08. The unobligated balance available on June 30, 1930, of all appropriations authorized and apportioned up to that date was \$816,349.40.

WYOMING

The Federal-aid highway system includes 3,498 miles, of which 1,708.7 miles have been improved with Federal aid. Of the improved mileage, 120.4 miles were added during the year. At the close of the year 241.1 miles were under construction and 13.7 miles had been approved.

The mileage improved with Federal aid consists of 531.6 miles of graded and drained earth roads, 10.6 miles of untreated sand-clay, 1,060.2 miles of untreated gravel, 61.9 miles of low-cost bituminous-mixed surface, 22.1 miles of bituminous concrete, and 15.9 miles of Portland cement concrete, in addition to which there are bridges and approaches with a total length of 6.4 miles.

The total cost of all Federal-aid roads completed during the year, including 36.3 miles of stage construction, was \$1,154,162.71, of which the Federal share was \$693,363.60. The disbursement of Federal funds to the State was \$958,322.93. The unobligated balance available on June 30, 1930, of all appropriations authorized and apportioned up to that date was \$588,414.28.

HAWAII

The Federal-aid highway system includes 217 miles, of which 41.2 miles have been improved with Federal aid. Of the improved mileage, 1.7 miles were added during the year. At the close of the year 21.5 miles were under construction and 9.2 miles had been approved.

The mileage improved with Federal aid consists of 1.7 miles of graded and drained earth roads, 6.9 miles of bituminous macadam, 13.3 miles of bituminous concrete, and 19 miles of Portland cement concrete, in addition to which there are bridges and approaches with a total length of 0.3 mile.

The total cost of all Federal-aid roads completed during the year was \$105,732.15, of which the Federal share was \$25,227. The disbursement of Federal funds to the State was \$79,118.49. The unobligated balance available on June 30, 1930, of all appropriations authorized and apportioned up to that date was \$1,568,624.59.

FEDERAL-AID STATISTICS

Statistical information relative to the apportionment, obligation, and disbursement of Federal aid during the fiscal year 1930, the cost of roads completed and the estimated cost of roads under construction, and the type of the roads completed and under construction, etc., is given in Tables 24 to 36, inclusive.

TABLE 24.—*Mileage of the designated Federal aid highway system in each State and mileage improved with Federal aid to June 30, 1930*

State	Mileage of designated Federal-aid highway system	Mileage completed with Federal aid to June 30, 1930	State	Mileage of designated Federal-aid highway system	Mileage completed with Federal aid to June 30, 1930
Alabama.....	3,884	2,153.8	New Hampshire.....	991	352.7
Arizona.....	1,979	810.3	New Jersey.....	1,186	507.8
Arkansas.....	5,019	1,741.4	New Mexico.....	3,466	1,904.4
California.....	4,889	1,880.2	New York.....	5,558	2,491.0
Colorado.....	3,332	1,208.1	North Carolina.....	4,219	1,780.6
Connecticut.....	836	243.3	North Dakota.....	7,424	4,262.6
Delaware.....	550	251.0	Ohio.....	5,899	2,190.4
Florida.....	1,926	503.5	Oklahoma.....	5,622	1,890.4
Georgia.....	5,554	2,703.3	Oregon.....	3,247	1,150.4
Idaho.....	3,116	1,194.1	Pennsylvania.....	5,487	2,341.9
Illinois.....	6,650	2,056.1	Rhode Island.....	417	184.7
Indiana.....	4,694	1,481.6	South Carolina.....	3,232	1,868.5
Iowa.....	7,212	2,979.7	South Dakota.....	6,148	3,445.1
Kansas.....	7,917	2,833.9	Tennessee.....	3,521	1,260.9
Kentucky.....	3,710	1,530.2	Texas.....	11,722	6,835.6
Louisiana.....	2,713	1,352.4	Utah.....	1,751	981.2
Maine.....	1,579	534.8	Vermont.....	1,043	255.6
Maryland.....	1,705	630.7	Virginia.....	3,565	1,467.9
Massachusetts.....	1,343	657.4	Washington.....	3,033	934.6
Michigan.....	5,238	1,605.2	West Virginia.....	2,214	710.1
Minnesota.....	6,885	3,936.1	Wisconsin.....	5,493	2,246.2
Mississippi.....	3,632	1,820.7	Wyoming.....	3,498	1,708.7
Missouri.....	7,530	2,486.8	Hawaii.....	217	41.2
Montana.....	5,108	1,717.4			
Nebraska.....	5,530	3,669.1	Total.....	193,049	84,012.8
Nevada.....	1,565	1,219.2			

TABLE 25.—*Total cost, Federal aid and mileage of Federal-aid roads, initial and stage construction completed during the fiscal year 1930*

State	Total cost	Federal aid	Mileage		
			Initial	Stage	Total
Alabama.....	\$3,073,848.12	\$1,443,082.40	194.2	14.5	208.7
Arizona.....	1,535,443.88	1,379,714.19	43.1	46.6	89.7
Arkansas.....	3,401,174.82	1,685,445.48	102.6	14.3	116.9
California.....	11,396,353.24	5,087,674.79	335.6	20.0	355.6
Colorado.....	1,883,264.93	994,769.96	72.3	38.1	110.4
Connecticut.....	770,370.16	255,295.83	14.1	-----	14.1
Delaware.....	835,954.86	406,222.78	45.2	-----	45.2
Florida.....	1,381,290.93	596,942.17	54.3	-----	54.3
Georgia.....	2,910,553.68	1,230,736.17	134.5	41.4	175.9
Idaho.....	937,768.62	565,258.96	77.1	-----	77.1
Illinois.....	5,021,954.42	2,201,666.48	169.0	-----	169.0
Indiana.....	6,693,965.53	3,142,358.52	214.7	-----	214.7
Iowa.....	5,075,345.20	2,411,131.90	66.8	146.6	213.4
Kansas.....	4,022,635.69	1,838,127.19	324.3	16.9	341.2
Kentucky.....	3,182,683.33	1,522,746.58	218.9	35.3	254.2
Louisiana.....	739,997.12	330,765.30	46.7	-----	46.7
Maine.....	1,897,734.54	684,782.89	54.3	-----	54.3
Maryland.....	947,200.70	457,092.20	34.1	14.7	48.8
Massachusetts.....	4,258,302.47	1,427,414.17	89.6	.7	90.3
Michigan.....	7,779,534.69	3,020,745.34	172.4	2.9	175.3
Minnesota.....	4,573,620.24	1,786,351.44	242.5	82.8	325.3
Mississippi.....	3,178,703.45	1,550,795.82	155.2	4.4	159.6
Missouri.....	10,177,544.47	4,125,021.08	217.0	138.8	355.8
Montana.....	2,557,945.61	1,565,807.28	214.1	4.1	218.2
Nebraska.....	2,280,225.35	1,078,362.13	137.8	161.4	299.2
Nevada.....	1,494,392.50	1,312,039.17	147.3	191.9	339.2
New Hampshire.....	683,180.62	289,036.37	19.0	1.0	20.0
New Jersey.....	3,757,925.87	677,880.00	45.1	-----	45.1
New Mexico.....	1,331,927.95	838,102.84	87.5	.7	88.2
New York.....	12,240,775.13	4,431,341.77	306.9	-----	306.9
North Carolina.....	1,694,550.53	798,658.46	90.8	9.5	100.3
North Dakota.....	3,931,493.45	1,630,756.04	577.2	392.5	969.7
Ohio.....	7,966,093.72	3,298,783.47	217.8	-----	217.8
Oklahoma.....	3,764,985.03	1,697,687.86	119.3	59.1	178.4
Oregon.....	1,129,094.63	597,022.73	87.9	-----	87.9
Pennsylvania.....	15,902,008.93	4,439,697.96	274.3	-----	274.3
Rhode Island.....	910,987.88	326,666.13	19.5	-----	19.5
South Carolina.....	3,511,295.63	1,016,308.31	98.9	45.0	143.9

TABLE 25.—*Total cost, Federal aid and mileage of Federal-aid roads, initial and stage construction completed during the fiscal year 1930—Continued*

State	Total cost	Federal aid	Mileage		
			Initial	Stage	Total
South Dakota.....	\$1, 594, 466. 64	\$852, 372. 53	243. 1	42. 2	285. 3
Tennessee.....	3, 088, 719. 17	1, 443, 055. 24	125. 2	-----	125. 2
Texas.....	16, 492, 620. 38	7, 347, 398. 73	636. 0	368. 1	1, 004. 1
Utah.....	1, 754, 707. 02	1, 138, 237. 82	73. 7	-----	73. 7
Vermont.....	1, 465, 991. 89	497, 157. 48	29. 4	-----	29. 4
Virginia.....	3, 984, 741. 95	1, 627, 334. 71	137. 3	21. 7	159. 0
Washington.....	4, 176, 691. 12	1, 493, 032. 99	101. 1	10. 4	111. 5
West Virginia.....	1, 968, 983. 06	744, 716. 04	39. 0	17. 6	56. 6
Wisconsin.....	9, 029, 204. 63	4, 154, 568. 49	288. 6	31. 7	320. 3
Wyoming.....	1, 154, 162. 71	693, 363. 60	120. 4	36. 3	156. 7
Hawaii.....	105, 732. 15	25, 227. 00	1. 7	-----	1. 7
Total.....	193, 648, 148. 64	82, 158, 756. 79	7, 317. 4	2, 011. 2	9, 328. 6

TABLE 26.—*Total cost, Federal aid and mileage of Federal-aid roads, initial and stage improvement, under construction on June 30, 1930, by States*

State	Estimated total cost	Federal aid allotted	Mileage		
			Initial	Stage	Total
Alabama.....	\$2, 326, 218. 40	\$1, 148, 172. 11	83. 2	22. 2	105. 4
Arizona.....	4, 114, 720. 89	3, 088, 393. 26	136. 5	149. 1	285. 6
Arkansas.....	5, 523, 331. 76	2, 530, 094. 42	142. 9	46. 2	189. 1
California.....	7, 170, 064. 91	2, 901, 983. 78	119. 4	27. 8	147. 2
Colorado.....	4, 989, 906. 87	2, 614, 893. 56	193. 6	28. 3	221. 9
Connecticut.....	2, 351, 390. 33	1, 047, 625. 20	10. 9	-----	10. 9
Delaware.....	900, 925. 60	357, 666. 32	24. 9	-----	24. 9
Florida.....	5, 127, 463. 61	2, 358, 944. 67	97. 1	5. 5	102. 6
Georgia.....	3, 140, 227. 85	1, 525, 964. 76	118. 6	32. 2	150. 8
Idaho.....	1, 315, 433. 28	793, 224. 26	85. 2	27. 8	113. 0
Illinois.....	15, 980, 580. 76	7, 088, 161. 17	454. 4	-----	454. 4
Indiana.....	4, 953, 074. 92	2, 363, 937. 39	153. 2	-----	153. 2
Iowa.....	7, 129, 677. 69	3, 036, 286. 94	66. 0	176. 9	242. 9
Kansas.....	5, 640, 308. 69	2, 707, 334. 03	248. 7	27. 8	276. 5
Kentucky.....	3, 736, 246. 74	1, 638, 751. 70	121. 6	5. 5	127. 1
Louisiana.....	4, 992, 472. 59	2, 432, 542. 49	153. 8	14. 3	168. 1
Maine.....	2, 327, 133. 99	869, 119. 44	57. 6	-----	57. 6
Maryland.....	1, 174, 932. 65	561, 046. 93	34. 8	6. 7	41. 5
Massachusetts.....	4, 280, 043. 25	1, 350, 586. 54	66. 0	-----	66. 0
Michigan.....	10, 006, 110. 54	4, 233, 567. 45	230. 6	30. 4	261. 0
Minnesota.....	10, 791, 550. 43	3, 818, 278. 31	232. 2	237. 5	469. 7
Mississippi.....	1, 795, 493. 20	691, 571. 41	55. 0	7. 7	62. 7
Missouri.....	7, 687, 851. 27	2, 665, 580. 20	117. 5	61. 3	178. 8
Montana.....	7, 874, 376. 59	4, 608, 614. 27	525. 9	43. 7	569. 6
Nebraska.....	7, 382, 359. 82	3, 442, 551. 75	272. 9	145. 9	418. 8
Nevada.....	802, 672. 12	713, 174. 12	-----	122. 1	122. 1
New Hampshire.....	1, 542, 914. 69	552, 098. 03	36. 6	-----	36. 6
New Jersey.....	5, 923, 349. 51	1, 476, 271. 32	66. 7	-----	66. 7
New Mexico.....	3, 711, 585. 77	2, 433, 941. 63	185. 3	50. 7	236. 0
New York.....	22, 301, 867. 76	4, 499, 355. 00	300. 4	-----	300. 4
North Carolina.....	3, 352, 750. 01	1, 652, 180. 40	146. 6	28. 9	175. 5
North Dakota.....	1, 987, 394. 70	1, 057, 103. 34	340. 5	127. 8	468. 3
Ohio.....	20, 873, 200. 95	6, 579, 243. 04	367. 8	35. 2	403. 0
Oklahoma.....	3, 804, 315. 31	1, 701, 181. 01	116. 4	47. 7	164. 1
Oregon.....	5, 343, 938. 89	3, 150, 289. 24	204. 5	85. 4	289. 9
Pennsylvania.....	16, 972, 451. 08	4, 590, 035. 23	211. 7	14. 1	225. 8
Rhode Island.....	1, 960, 716. 15	668, 452. 68	28. 2	-----	28. 2
South Carolina.....	4, 495, 500. 70	1, 927, 574. 94	98. 3	80. 3	178. 6
South Dakota.....	4, 526, 179. 47	2, 422, 855. 94	454. 1	142. 0	596. 1
Tennessee.....	3, 278, 768. 07	1, 518, 961. 84	132. 3	12. 5	144. 8
Texas.....	12, 367, 394. 51	5, 019, 494. 74	376. 3	119. 8	496. 1
Utah.....	1, 172, 923. 88	810, 322. 47	56. 3	10. 8	67. 1
Vermont.....	2, 165, 910. 24	756, 716. 81	42. 5	1. 2	43. 7
Virginia.....	4, 290, 724. 92	2, 021, 632. 97	203. 1	13. 6	216. 7
Washington.....	3, 992, 309. 81	1, 713, 300. 00	96. 5	29. 8	126. 3
West Virginia.....	3, 474, 452. 68	1, 322, 067. 98	75. 0	27. 8	102. 8
Wisconsin.....	7, 729, 781. 66	3, 114, 270. 98	197. 6	48. 1	245. 7
Wyoming.....	2, 122, 570. 69	1, 382, 750. 59	148. 5	92. 6	241. 1
Hawaii.....	853, 565. 90	359, 459. 43	21. 5	-----	21. 5
Total.....	271, 259, 136. 10	111, 317, 626. 09	7, 709. 2	2, 187. 2	9, 896. 4

TABLE 27.—*Total cost, Federal aid and mileage of Federal-aid roads, initial and stage improvement, approved for construction, as of June 30, 1930, by States*

State	Estimated total cost	Federal aid allotted	Mileage		
			Initial	Stage	Total
Alabama.....	\$13,545.40	\$6,772.70	-----	-----	-----
Arizona.....	116,572.12	87,767.12	-----	15.8	15.8
Arkansas.....	1,759,692.74	879,846.76	86.4	3.5	89.9
California.....	1,577,783.43	698,070.27	36.1	2.1	38.2
Colorado.....	1,232,562.53	617,597.98	29.0	69.0	98.0
Connecticut.....	446,379.45	117,900.00	7.9	-----	7.9
Delaware.....	732,886.27	362,874.26	41.2	-----	41.2
Georgia.....	2,962,085.96	1,360,367.13	59.6	68.4	128.0
Idaho.....	996,404.66	541,576.25	54.3	42.4	96.7
Illinois.....	6,282,202.65	2,808,075.49	153.9	63.5	217.4
Indiana.....	241,360.20	120,680.10	9.9	-----	9.9
Iowa.....	1,140,139.79	475,042.91	11.8	27.8	39.6
Kansas.....	645,979.77	321,602.02	20.6	89.5	110.1
Kentucky.....	4,738,366.79	2,265,599.85	50.5	228.7	279.2
Louisiana.....	1,654,549.25	805,908.66	49.0	11.4	60.4
Maine.....	855,359.95	303,619.53	23.9	-----	23.9
Maryland.....	883,765.93	441,838.21	26.0	-----	26.0
Massachusetts.....	2,465,209.61	444,715.17	11.3	-----	11.3
Michigan.....	824,037.67	363,275.00	30.1	-----	30.1
Minnesota.....	1,232,803.68	490,675.40	19.4	32.3	51.7
Mississippi.....	48,835.05	24,417.52	.1	-----	.1
Missouri.....	3,642,322.65	1,248,339.72	61.6	27.7	89.3
Montana.....	1,120,677.78	641,330.56	90.2	40.7	130.9
Nebraska.....	1,578,049.64	636,872.07	54.7	91.1	145.8
Nevada.....	348,831.87	307,040.69	-----	81.0	81.0
New Mexico.....	643,139.21	479,303.52	32.6	1.9	34.5
New York.....	7,348,800.00	1,251,572.50	83.6	-----	83.6
North Carolina.....	845,693.09	401,143.99	25.8	1.9	27.7
North Dakota.....	1,221,468.57	605,444.83	151.3	207.1	358.4
Ohio.....	5,055,233.63	1,732,197.73	83.1	13.1	96.2
Oklahoma.....	3,192,412.33	1,482,314.49	92.7	49.7	142.4
Oregon.....	819,262.95	490,778.04	49.1	-----	49.1
Pennsylvania.....	6,603,495.13	1,978,331.84	87.1	-----	87.1
South Carolina.....	1,463,356.75	529,064.20	27.2	26.2	53.4
South Dakota.....	586,201.87	368,755.17	44.0	70.6	114.6
Tennessee.....	2,817,321.13	1,107,295.27	82.3	38.2	120.5
Texas.....	2,945,441.96	1,207,057.26	101.6	52.7	154.3
Utah.....	704,739.73	516,652.55	44.9	78.8	123.7
Vermont.....	316,892.92	45,829.37	5.7	-----	5.7
Virginia.....	833,708.70	395,539.94	28.0	-----	28.0
Washington.....	248,056.42	144,900.00	2.1	6.5	8.6
West Virginia.....	1,184,345.87	386,995.23	20.5	17.2	37.7
Wisconsin.....	992,121.83	424,875.00	28.0	-----	28.0
Wyoming.....	453,127.23	339,821.63	13.7	63.2	76.9
Hawaii.....	226,820.16	113,414.57	9.2	-----	9.2
Total.....	76,042,044.32	30,373,092.50	1,940.0	1,522.0	3,462.0

TABLE 28.—*Mileage of Federal-aid roads improved, as of June 30, 1930, by types of construction, by States*

State	Graded and drained	Sand-clay		Gravel		Macadam		Low-cost bituminous mix	Bituminous macadam	Bituminous concrete	Portland cement concrete	Block	Bridges and approaches	Total
		Untreated	Treated	Untreated	Treated	Untreated	Treated							
Alabama	259.7	523.2		940.1	4.4		20.8		62.8	104.3	223.6		9.9	2,153.8
Arizona	80.2	58.8		462.0				55.8		38.1	109.3		6.1	810.3
Arkansas	86.3			1,029.4	6.4	41.5	110.6			257.9	197.4		11.9	1,741.4
California	382.5			468.7		22.5		133.6	96.8	174.7	590.8		10.6	1,880.2
Colorado	200.5	67.1		458.7		101.2		47.7		13.1	306.1		13.7	1,208.1
Connecticut				.2		17.2			39.7	.6	181.6		4.0	243.3
Delaware				11.2				11.7			221.3	6.2	.6	251.0
Florida	14.9	15.6			1.0	85.4	67.0		72.6	60.7	168.0	10.2	8.1	503.5
Georgia	214.7	1,129.4		441.0	3.7	52.3	88.5		207.3	54.2	481.5	.5	30.2	2,703.3
Idaho	180.8			582.3		244.1		28.5	20.4		44.6		3.7	1,194.1
Illinois	183.9			.4					3.3	8.1	1,832.8	25.4	2.2	2,056.1
Indiana	16.9			90.2					17.0	12.0	1,334.8	6.6	4.1	1,481.6
Iowa	1,201.5			521.1							1,233.1	21.9	2.1	2,979.7
Kansas	1,277.5	276.6		239.7		4.5			129.9	3.5	722.2	166.0	14.0	2,833.9
Kentucky	1,682.0			390.0		20.4	50.3		84.3	115.2	180.1	3.9	4.0	1,530.2
Louisiana	35.1			1,219.8					3.2	43.0	39.8		11.5	1,552.4
Maine				222.8	28.3				175.3		107.8		.6	534.8
Maryland	4.7			31.5		.1	3.9		224.9	31.5	334.1		4.6	630.7
Massachusetts				.5	.4	.1	2.8	22.0	306.2	56.4	204.4	.4	2.4	657.4
Michigan	8.6			342.7			16.3		10.4	69.0	1,155.4		1.6	1,605.2
Minnesota	1,000.6	11.1		2,079.0	17.6					32.7	793.5		10.2	3,936.1
Mississippi	294.6	15.8		1,220.6		11.1				12.4	246.3	9.7	10.4	1,820.7
Missouri	392.3			752.8		27.2			43.0	20.1	1,220.1	20.9	6.0	2,456.8
Montana	210.2			1,442.9				8.8		12.5	37.0		12.5	1,717.4
Nebraska	504.6	3,027.1	0.8					3.8		14.6	90.1	19.6	8.5	3,669.1
Nevada	46.8			805.1	14.3			282.5	20.6	1.9	45.2		2.8	1,219.2
New Hampshire							74.8		86.1	35.9	54.5		3.9	352.7
New Jersey	11.8						.2	17.2	.5	22.5	464.4		2.4	507.8
New Mexico	265.7	27.3		6.0						.7	82.5	.7	4.1	1,904.4
New York	46.9			1,506.9					402.5	11.5	1,951.0		2.0	2,491.0
North Carolina	87.9	474.6		76.4					35.6	256.9	824.0		4.0	1,780.6
North Dakota	1,375.8	10.8		2,779.8	80.6	19.6				1.1	6.6	522.7	7.9	4,262.6
Ohio	120.6			9.4		110.7	26.1		356.5	156.1	883.8		4.5	2,190.4
Oklahoma	378.5	.7		559.2	8.3	28.8			.5	151.0	741.1	8.9	13.4	1,890.4
Oregon	235.3			711.5		25.6			14.2	64.2	94.7		4.9	1,150.4
Pennsylvania							10.6		7.7	98.4	2,026.8	39.5	2.0	2,341.9
Rhode Island							1.8		57.1	48.1	76.8		.9	184.7
South Carolina									3.1	186.0	303.7		22.7	1,863.5
South Dakota	43.3	1,202.0		107.7				9.5			12.9		3.9	3,445.1
Texas	835.3	39.4		2,857.6	292.2	61.5	119.7	19.8	361.7	121.6	497.9	30.2	7.2	6,835.6
Utah	110.9			146.8	3.4	560.9		39.2	521.8	709.6	1,307.1		2.7	981.2

TABLE 28.—*Mileage of Federal-aid roads improved, as of June 30, 1930, by types of construction, by States—Continued*

State	Graded and drained	Sand-clay		Gravel		Macadam		Low-cost bituminous mix	Bituminous macadam	Bituminous concrete	Portland cement concrete	Block	Bridges and approaches	Total
		Untreated	Treated	Untreated	Treated	Untreated	Treated							
Vermont				106.6	2.0	1.2			51.6		89.6		4.6	255.6
Virginia	85.0	216.3		101.3		133.8	9.4		374.1	39.8	502.1		6.1	1,467.9
Washington	179.4			420.4							329.8		5.0	934.6
West Virginia	249.6			28.3		14.2	.6		185.0	28.7	190.2	11.4	2.1	710.1
Wisconsin	144.2	23.8		1,030.2	19.9				13.7	.4	1,007.1		6.9	2,246.2
Wyoming	531.6	10.6		1,060.2				61.9		22.1	15.9		6.4	1,708.7
Hawaii	1.7								6.9	13.3	19.0		.3	41.2
Total	12,448.5	7,166.2	16.5	28,607.9	482.5	1,754.1	603.4	742.0	4,057.1	3,204.7	23,693.3	904.7	331.9	84,012.8

TABLE 29.—*Mileage of Federal-aid roads initially completed during the fiscal year 1930, by types of construction, by States*

State	Graded and drained	Sand-clay		Gravel		Macadam		Low-cost bituminous mix	Bituminous macadam	Bituminous concrete	Portland cement concrete	Block	Bridges and approaches	Total
		Untreated	Treated	Untreated	Treated	Untreated	Treated							
Alabama	130.9			20.3						16.9	24.3		1.8	194.2
Arizona	44.4			-8.4				5.9					1.2	43.1
Arkansas	25.7			29.2							41.9		2.8	102.6
California	56.5			73.1				105.2		58.1	40.9		1.8	335.6
Colorado	2.3			56.6				7.9			4.6		.9	72.3
Connecticut									10.8		3.2		.1	14.1
Delaware				11.2				6.8			27.2			45.2
Florida	12.6						16.1		51.3	7.1	17.9		.6	54.3
Georgia	17.0	6.8					-3.4		15.5		62.7		.1	134.5
Idaho	3.6			54.7		3.3								77.1
Illinois	29.8										138.8		.4	169.0
Indiana											214.3		.4	214.7
Iowa				4.9							61.9			66.8
Kansas	282.3	.4		3.5					4.5		28.2		2.2	324.3
Kentucky	89.6			106.1					12.3		9.8	3.2	1.1	218.9
Louisiana	4.5			41.3									.9	46.7
Maine				5.8	21.9				9.6		17.0			54.3
Maryland									23.6		10.5			34.1
Massachusetts									66.2	14.9	8.3		.2	89.6
Michigan	8.0			14.5							148.7		1.2	172.4

Minnesota	224.3						60.1	17.7											.3		.2	242.5
Mississippi	55.1						4.4												.5		2.5	155.2
Missouri	108.3						203.5														1.7	217.0
Montana	.4																8.9	.3			1.0	214.1
Nebraska	10.2		120.2																6.9		.5	137.8
Nevada							141.0										6.3					147.3
New Hampshire																			16.6			19.0
New Jersey	2.9						.2										1.8					19.0
New Mexico	39.2						30.4										.5	41.0				45.1
New York	25.5						13.2										17.2	.3	.2			87.5
North Carolina	4.5		40.2														40.5		.5		.1	306.9
North Dakota	423.1						119.9	32.5										227.6	.8		.3	90.8
Ohio	40.3						1.0										20.7	40.7	.9		.9	577.2
Oklahoma	46.4																	126.6	22.6	1.4		217.8
Oregon	65.8						13.1										3.3	67.6	.4		.4	119.3
Pennsylvania	18.6																3.5	4.6	.9		.9	87.9
Rhode Island																		242.5	13.2			274.3
South Carolina	23.7		29.7														12.8	2.3	.3		.3	19.3
South Dakota	65.5		16.7															43.6	.4		.4	98.9
Tennessee	61.2						156.6											3.7		.6		243.1
Texas	490.3							-5.8										56.2	2.1			125.2
Utah	5.8						3.0										-18.8	161.2	5.1			636.0
Vermont							51.2											6.4	.3			73.7
Virginia							.4											28.6	.4			73.7
Washington	32.6		13.1				1.0										47.0	13.7	1.3			137.3
West Virginia	34.5						43.7											22.3	.6			101.1
Wisconsin	3.1																16.7	13.1	.3			39.0
Wyoming	65.1						74.4											210.4	2.9			288.6
Hawaii	1.7						52.6										2.2		.5			120.4
Total	2,556.2	227.1					1,382.5	66.3	36.2	14.1	160.4	318.5	135.2	2,340.3	40.0	40.6						7,317.4

South Dakota	254.4	198.4																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																
--------------	-------	-------	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

TABLE 31.—Mileage of Federal-aid roads approved for initial construction on June 30, 1930, by types of construction, by States

State	Graded and drained	Sand-clay		Gravel		Macadam		Low-cost bitumi- nous mix	Bitumi- nous macadam	Bitumi- nous concrete	Portland cement concrete	Block	Bridges and ap- proaches	Total
		Untreated	Treated	Untreated	Treated	Untreated	Treated							
Alabama.....														
Arizona.....														
Arkansas.....	60.6										24.0		1.8	86.4
California.....	3.5									9.5	4.8		.4	36.1
Colorado.....	1.7							9.9			1.3			29.0
Connecticut.....									3.0		4.9			7.9
Delaware.....									2.4		35.2			41.2
Florida.....														
Georgia.....	7.6					14.6					37.3		.1	59.6
Idaho.....	9.1												.1	54.3
Illinois.....	42.9			45.1							110.3		.7	153.9
Indiana.....											9.9			9.9
Iowa.....											11.8			11.8
Kansas.....	17.1										3.0		.5	20.6
Kentucky.....	7.1							14.0			11.2		.1	50.5
Louisiana.....				9.7							39.0		.3	49.0
Maine.....				5.6	8.0				3.6		6.7			23.9
Maryland.....											25.9		.1	26.0
Massachusetts.....											10.6		.7	11.3
Michigan.....	11.1			5.8							13.2			30.1
Minnesota.....	10.2										9.2			19.4
Mississippi.....											.1			.1
Missouri.....											61.6			61.6
Montana.....	42.0			48.1									.1	90.2
Nebraska.....		54.6											.1	54.7
Nevada.....														
New Hampshire.....														
New Jersey.....														
New Mexico.....	4.2			32.6										
New York.....		18.0							16.3	1.1	62.0			32.6
North Carolina.....	151.2										7.6		.2	83.6
North Dakota.....												16.5	.1	25.8
Ohio.....				4.4			3.6		2.5	2.1	52.9		.8	151.3
Oklahoma.....	58.0										33.9		.8	83.1
Oregon.....	38.6								2.9		6.8		.8	92.7
Pennsylvania.....	8.4					1.2					72.9	3.7	.9	49.1
Rhode Island.....														87.1
South Carolina.....		15.4									11.4		.4	27.2

South Dakota	43.4																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																		
--------------	------	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

TABLE 32.—Mileage of Federal-aid stage construction completed during the fiscal year 1930, by types of construction, by States

State	Graded and drained	Sand-clay		Gravel		Macadam		Low-cost bituminous mix	Bituminous macadam	Bituminous concrete	Portland cement concrete	Block	Bridges and approaches	Total
		Untreated	Treated	Untreated	Treated	Untreated	Treated							
Alabama											14.5			14.5
Arizona	9.6			0.6				36.3					0.1	46.6
Arkansas											14.0			14.3
California	9.4			1.0							9.3		.3	20.0
Colorado								34.5					1.2	38.1
Georgia				7.8					15.2		14.6			41.4
Iowa				15.2			3.8				131.4			146.6
Kansas											16.9			16.9
Kentucky				35.3										35.3
Maryland											14.7			14.7
Massachusetts											1		.6	.7
Michigan											2.9			2.9
Minnesota	11.2										71.6			82.8
Mississippi				3.2							1.0			4.4
Missouri	10.8										127.6		.4	138.8
Montana				3.9									.2	4.1
Nebraska		154.2	0.8		-0.9					0.4	6.8		.1	161.4
Nevada				16.8				174.9					.2	191.9
New Hampshire											1.0			1.0
New Mexico											.7			.7
North Carolina		1.1									8.3		.1	9.5
North Dakota				344.1	48.0						.4			392.5
Oklahoma											59.1		.1	59.1
South Carolina											22.7			45.0
South Dakota	3.0			31.7				5.5			2.0			42.2
Texas	6.1								81.4	17.5	262.4		.7	368.1
Virginia										14.8	6.8		.1	21.7
Washington				10.4										10.4
West Virginia						9.9					7.7			17.6
Wisconsin											31.1		.6	31.7
Wyoming				19.0				17.2					.1	36.3
Total	50.1	155.3	.8	489.0	47.1	9.9	3.8	268.4	96.6	54.9	830.0		5.3	2,011.2

TABLE 33.—Mileage of Federal-aid roads under stage construction on June 30, 1930, by types of construction, by States

State	Graded and drained	Sand-clay		Gravel		Macadam		Low-cost bituminous mix	Bituminous macadam	Bituminous concrete	Portland cement concrete	Block	Bridges and approaches	Total
		Untreated	Treated	Untreated	Treated	Untreated	Treated							
Alabama											22.0		0.2	22.2
Arizona	39.7							109.0					.4	149.1
Arkansas											38.5		.2	46.2
California	7.9			7.5							13.9		.7	27.8
Colorado				5.3				9.3			16.4		.4	28.3
Florida				2.2									.1	5.5
Georgia							5.4			16.0	13.4			32.2
Idaho							2.8							27.8
Iowa				27.8							176.9			176.9
Kansas	1.5										26.3			27.8
Kentucky											5.4		.1	5.5
Louisiana											14.2		.1	14.3
Maryland											6.7			6.7
Michigan											30.4			30.4
Minnesota	51.3									.1	186.0		.1	237.5
Mississippi	7.6												.1	7.7
Missouri											61.2		.1	61.3
Montana				.8				42.8					.1	43.7
Nebraska	.3	30.0									115.0		.6	145.9
Nevada								122.1						122.1
New Mexico				17.8				31.4						50.7
North Carolina	13.5			6.8							8.5		.1	28.9
North Dakota	24.3			79.6	23.9									127.8
Ohio											25.6	8.5	1.1	35.2
Oklahoma											47.7			47.7
Oregon	1.2			6.6					77.5				.1	85.4
Pennsylvania											14.1			14.1
South Carolina											80.3			80.3
South Dakota	19.9			101.6							20.4		.1	142.0
Tennessee											12.5			12.5
Texas					7.6				13.1		98.8		.3	119.8
Utah				7.8				2.8			.2			10.8
Vermont											1.2			1.2
Virginia						0.8			9.8		2.2		.8	13.6
Washington	18.1			11.7										29.8
West Virginia						5.4					22.4			27.8
Wisconsin											48.1			48.1
Wyoming	.8			37.8				53.7					.3	92.6
Total	186.1	30.0		313.3	31.5	6.2	8.2	371.1	100.4	16.1	1,108.3	8.5	7.5	2,187.2

TABLE 34.—Mileage of Federal-aid roads approved for stage construction on June 30, 1930, by types of construction, by States

State	Graded and drained	Sand-clay		Gravel		Macadam		Low-cost bitumi- nous mix	Bitumi- nous macadam	Bitumi- nous concrete	Portland cement concrete	Block	Bridges and ap- proaches	Total
		Untreated	Treated	Untreated	Treated	Untreated	Treated							
Arizona.....								15.8						15.8
Arkansas.....	3.5													3.5
California.....											2.1			2.1
Colorado.....				6.4			14.7	62.6			53.6		0.1	69.0
Georgia.....											5.3			68.4
Idaho.....				3.5				33.6			63.5			42.4
Illinois.....											27.8			63.5
Iowa.....		47.5		35.7							6.0		.2	27.8
Kansas.....	.1			27.6				155.8	1.7	3.4	40.1		.1	228.7
Kentucky.....											11.3			11.4
Louisiana.....											32.3			32.3
Minnesota.....											27.7			27.7
Missouri.....														
Montana.....				11.5				29.2			21.7		.1	40.7
Nebraska.....		69.3						81.0						91.1
Nevada.....											1.9			1.9
New Mexico.....										1.9				1.9
North Carolina.....	7.9							15.5			12.9		.2	207.1
North Dakota.....				174.7	9.0						47.0		.1	13.1
Ohio.....	2.6										26.2			49.7
Oklahoma.....														26.2
South Carolina.....											38.2			70.6
South Dakota.....	17.9			52.7							52.7			38.2
Tennessee.....														52.7
Texas.....														78.8
Utah.....								78.8						78.8
Washington.....				6.5										6.5
West Virginia.....	7.8			22.8				40.4	1.8		7.6			17.2
Wyoming.....														63.2
Total.....	39.8	116.8		341.4	9.0		14.7	512.7	3.5	5.3	477.9		.9	1,522.0

TABLE 35.—Net changes in the types of Federal-aid improvements on the Federal-aid highway system during fiscal year 1930

State	Graded and drained	Sand-clay		Gravel		Macadam		Low-cost bituminous mix	Bituminous macadam	Bituminous concrete	Portland cement concrete	Block	Bridges and approaches	Total
		Untreated	Treated	Untreated	Treated	Untreated	Treated							
Alabama	116.7			19.0				42.2		16.9	38.7		1.8	193.1
Arizona	49.5	-0.5		-168.8									1.6	-76.0
Arkansas	21.9			-46.8		-5.4	-32.3				58.9		2.9	-8
California	52.6			62.8				105.9	-0.8	58.1	37.1		1.9	317.6
Colorado	-10.1			29.3				42.4			6.9		1.9	70.4
Connecticut						-2			11.0		3.1		.1	14.0
Delaware				11.2				6.7			27.3		.1	45.3
Florida	12.4	.3								7.2	17.9		.6	54.5
Georgia	-7.7	-4.9		7.0	3.7		16.1		66.5		77.4		.1	138.6
Idaho	-20.5			50.9		3.3	-28.5	28.5	15.6				.1	49.4
Illinois	29.8													49.4
Indiana											138.8			169.0
Iowa	-137.3			-79.4							214.2		.5	214.7
Kansas	241.6	-4.1		3.5					4.4		187.2		.2	-29.3
Kentucky	57.6			135.9					12.3		44.0	2.6	2.4	294.4
Louisiana	4.4			27.1							9.9		1.0	216.7
Maine				5.9	21.8				7.6		19.0		.8	32.3
Maryland									20.6		.9			51.3
Massachusetts									63.0	12.3	11.0			21.5
Michigan	8.0			-15.7									.1	86.4
Minnesota	152.2			-173.2	17.6						151.6		1.2	145.1
Mississippi	60.5			63.0						.5	71.9		.3	68.8
Missouri	4.1			-23.0					.5		38.0		2.6	164.6
Montana	.4			167.7				8.8			225.4		2.0	209.0
Nebraska	-96.3	132.6								.4	.4		.4	178.5
Nevada	-13.5			-31.3				181.2			13.6		.1	50.7
New Hampshire						.1	.5		2.4	-2.7	1.0			137.5
New Jersey	2.9			.2			.2		.5		19.7			20.0
New Mexico	39.2			-20.5						.3	41.0			45.1
New York	25.5			13.2				17.2	40.5		1.2		-4	36.7
North Carolina	-15.9	30.2		-7						5.1	227.5		.1	306.8
North Dakota	38.8	-5.2		469.1	80.6						48.9		.5	68.1
Ohio	26.8			1.0			3.3		15.7	-7.5	125.2	21.5	1.4	585.4
Oklahoma	-24.0			-15.9					3.5	-3.0	111.3		.3	187.4
Oregon	65.8			-72.3		-10.6	10.6				4.6		.8	68.7
Pennsylvania	18.6									-2.3	242.6	13.1	.1	272.1
Rhode Island									12.8	4.1	2.4		.2	19.5
South Carolina	15.2	-52.9								23.8	66.2		.5	52.8

TABLE 35.—*Net changes in the types of Federal-aid improvements on the Federal-aid highway system during fiscal year 1930—Continued*

State	Graded and drained	Sand-clay		Gravel		Macadam		Low-cost bitumi- nous mix	Bitumi- nous macadam	Bitumi- nous concrete	Portland cement concrete	Block	Bridges and ap- proaches	Total
		Untreated	Treated	Untreated	Treated	Untreated	Treated							
South Dakota.....	-37.0	16.7	-----	142.3	-----	-----	-----	5.5	-----	-----	5.7	-----	0.6	133.8
Tennessee.....	48.1	-----	-----	-----	-----	-----	-----	-----	-----	5.7	56.1	-----	2.6	112.5
Texas.....	269.3	8.4	-----	-13.8	-5.9	-----	-----	-----	62.7	17.5	423.7	1.0	5.5	768.4
Utah.....	5.8	-----	-----	51.1	-----	-0.7	-----	-----	-----	.1	6.4	-----	.3	63.0
Vermont.....	-----	-----	-----	-2.3	-----	-.2	-----	-----	-----	-----	28.6	-----	.4	26.5
Virginia.....	32.3	10.4	-----	1.0	-----	10.9	-2.7	-----	31.9	23.2	15.1	-----	.5	122.6
Washington.....	24.1	-----	-----	54.1	-----	-----	-----	-----	-----	-----	22.3	-----	.6	101.1
West Virginia.....	-24.5	-----	-----	-----	-----	-----	-----	-----	14.5	5.8	20.8	-----	.2	26.7
Wisconsin.....	-15.8	-9.9	-----	-3.1	-----	9.9	-----	-----	-----	-----	-----	-----	3.5	191.4
Wyoming.....	17.5	-4.0	-----	12.5	-----	-----	-----	9.4	-----	-----	216.7	-----	.6	36.0
Hawaii.....	1.7	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	1.7
Total.....	1,040.7	117.1	-----	661.0	117.8	7.1	-36.3	447.8	385.2	165.5	3,081.4	38.2	43.5	6,069.0

TABLE 36.—*Federal-aid apportionment, and amounts paid to the States for the fiscal year 1930, and the unobligated balance of the total apportionment on June 30, 1930*

State	Apportionment fiscal year 1930	Paid to States during the fiscal year 1930	Unobligated bal- ances of total apportionment on June 30, 1930
Alabama.....	\$1,554,221.00	\$1,092,685.93	\$4,083,610.18
Arizona.....	1,061,111.00	1,560,058.27	1,898,927.83
Arkansas.....	1,284,382.00	650,764.79	1,518,012.42
California.....	2,495,345.00	3,931,822.91	1,743,512.14
Colorado.....	1,388,755.00	1,402,520.46	2,283,553.54
Connecticut.....	477,110.00	281,922.76	714,247.71
Delaware.....	365,625.00	594,597.88	91,051.91
Florida.....	909,235.00	660,158.48	1,681,203.79
Georgia.....	1,980,443.00	623,085.28	2,902,272.18
Idaho.....	933,902.00	574,315.68	1,175,024.06
Illinois.....	3,118,949.00	1,908,477.62	4,656,255.25
Indiana.....	1,917,036.00	2,295,345.32	2,473,551.58
Iowa.....	2,020,861.00	2,504,338.70	1,892.77
Kansas.....	2,058,305.00	2,541,954.83	2,063,112.86
Kentucky.....	1,417,634.00	1,537,194.33	114,878.62
Louisiana.....	1,026,696.00	852,639.40	1,224,288.48
Maine.....	678,501.00	1,187,526.36	1,354,501.03
Maryland.....	633,615.00	466,652.87	5,543.03
Massachusetts.....	1,090,077.00	1,546,517.25	1,944,255.39
Michigan.....	2,204,966.00	2,300,913.73	2,782,145.14
Minnesota.....	2,108,104.00	2,192,899.80	46,352.03
Mississippi.....	1,311,391.00	745,258.17	3,527,955.68
Missouri.....	2,392,021.00	3,436,554.13	831,704.84
Montana.....	1,554,060.00	2,571,899.09	3,540,456.15
Nebraska.....	1,586,299.00	1,980,717.15	2,176,337.14
Nevada.....	960,375.00	996,033.53	773,969.02
New Hampshire.....	365,625.00	464,211.66	221,369.45
New Jersey.....	937,434.00	629,055.00	977,248.76
New Mexico.....	1,189,085.00	827,764.88	969,531.76
New York.....	3,617,748.00	4,078,108.85	7,315,347.86
North Carolina.....	1,716,919.00	711,610.60	2,560,469.31
North Dakota.....	1,197,586.00	1,236,250.08	1,452,524.56
Ohio.....	2,754,446.00	2,455,602.56	939,205.53
Oklahoma.....	1,748,857.00	2,080,335.52	184,302.92
Oregon.....	1,191,989.00	703,274.47	288,573.31
Pennsylvania.....	3,325,854.00	3,710,013.31	1,082,376.94
Rhode Island.....	365,625.00	171,477.02	588,570.42
South Carolina.....	1,061,447.00	926,038.22	97,283.99
South Dakota.....	1,229,282.00	1,162,383.12	1,062,892.43
Tennessee.....	1,609,662.00	1,459,546.34	1,552,381.84
Texas.....	4,531,162.00	6,292,484.66	4,647,819.57
Utah.....	848,592.00	730,519.47	662,833.17
Vermont.....	365,625.00	366,821.03	-----
Virginia.....	1,433,405.00	1,090,622.55	691,693.83
Washington.....	1,149,489.00	1,377,438.14	1,211,773.29
West Virginia.....	796,408.00	874,504.14	628,588.82
Wisconsin.....	1,854,580.00	3,058,505.08	816,349.40
Wyoming.....	939,536.00	958,322.93	588,414.28
Hawaii.....	365,625.00	79,118.49	1,568,624.59
Total.....	73,125,000.00	75,880,862.84	75,716,790.80

NATIONAL-FOREST ROAD CONSTRUCTION

During the past year improvements have been completed on 266.8 miles of the forest-road system, bringing the total mileage improved to date with Federal funds to 4,357.5 miles. Of the mileage improved during the year, 244.7 miles were in the Western States and Alaska, and the remaining 22.1 miles were in the forests of four Eastern States. Of the total mileage improved to date, 4,026.7 miles are in the West and 330.8 in the East.

The mileage of forest-highway projects completed during the year and to date by States is shown in Table 37.

TABLE 37.—*Mileage of completed forest-highway projects, by States*

State	Mileage of forest-highway projects completed—		State	Mileage of forest-highway projects completed—	
	During 1930	Total to June 30, 1930		During 1930	Total to June 30, 1930
Western:			Eastern:		
Alaska.....	17.5	222.0	Alabama.....		5.1
Arizona.....	28.3	336.2	Arkansas.....	5.4	65.2
California.....	66.9	383.7	Florida.....		64.2
Colorado.....	13.6	345.7	Georgia.....		21.4
Idaho.....	24.1	508.4	Michigan.....		8.1
Montana.....	24.5	391.7	Minnesota.....	11.7	60.6
Nevada.....	3.6	114.5	New Hampshire.....	1.6	5.2
New Mexico.....	2.2	190.4	North Carolina.....		36.3
Oregon.....	30.4	677.5	South Carolina.....		16.0
South Dakota.....		46.2	Tennessee.....		33.5
Utah.....	7.0	307.9	Virginia.....	3.4	15.2
Washington.....	11.9	227.7			
Wyoming.....	14.7	274.8	Total.....	22.1	330.8
Total.....	244.7	4,026.7	Grand total.....	266.8	4,357.5

In the forest-highway system as approved to date there are 14,576.1 miles, of which 12,378.8 miles are in the Western States and Alaska and 2,197.3 miles are in the Eastern States. Class 1 highways, which are necessary sections or extensions of the Federal-aid highway system lying wholly within the forest areas, total 1,316.1 miles, of which 924.1 miles are in the Western States. Class 2 highways, which also extend the Federal-aid system, total 7,293.4 miles, of which 6,961.8 are in the West. The class 3 highways, those that serve communities within the forests, total 5,966.6 miles, of which 4,492.9 miles are in the Western States.

The mileage of each of the three classes of highways and the total mileage of the forest-highway system in each State are shown in Table 38.

TABLE 38.—*Classified mileage of forest-highway system, by States*

State	Mileage of forest-highway system			
	Class 1	Class 2	Class 3	Total
Western:				
Alaska.....			415.1	415.1
Arizona.....	263.3	491.0	255.0	1,009.3
California.....	321.5	991.0	926.3	2,238.8
Colorado.....		1,240.0	483.0	1,723.0
Idaho.....	4.0	760.7	328.5	1,093.2
Montana.....	147.4	657.2	381.0	1,185.6
Nevada.....		373.8	97.0	470.8
New Mexico.....	115.0	211.0	199.0	525.0
Oregon.....	66.2	782.4	591.2	1,439.8
South Dakota.....	2.0	169.0	63.0	234.0
Utah.....		457.9	290.2	748.1
Washington.....	4.7	472.8	311.6	789.1
Wyoming.....		355.0	152.0	507.0
Total.....	924.1	6,961.8	4,492.9	12,378.8
Eastern:				
Alabama.....			41.0	41.0
Arkansas.....	169.8	34.0	14.0	217.8
Florida.....		0.7	106.0	106.7
Georgia.....			99.0	99.0
Maine.....			11.0	11.0
Michigan.....		13.4	53.0	66.4
Minnesota.....	41.0	38.5	166.0	245.5
Nebraska.....			28.8	28.8
New Hampshire.....	30.0	50.0	49.0	129.0
North Carolina.....	78.7	50.0	108.9	237.6
Oklahoma.....			33.0	33.0
Pennsylvania.....	24.5	16.0	157.0	197.5
South Carolina.....		6.0	40.0	46.0
Tennessee.....	48.0	81.0	167.0	296.0
Virginia.....		38.0	269.0	307.0
West Virginia.....		4.0	131.0	135.0
Total.....	392.0	331.6	1,473.7	2,197.3
Grand total.....	1,316.1	7,293.4	5,966.6	14,576.1

Progress in improvement of the system, which has been maintained at about the present rate for several years, will now be accelerated as a result of the increased funds authorized for appropriation for the fiscal years 1931, 1932, and 1933. For these three years the total forest-road appropriation authorized is \$12,500,000 (includes \$3,000,000 for forest development roads not necessarily on the system) instead of the \$7,500,000 which has been authorized for several years past.

The demand for a higher type of construction on forest highways, especially those of classes 1 and 2, which are included in the Federal-aid and State systems, is evidenced by the fact that a number of projects recently graded and surfaced by the bureau with fine crushed rock have been immediately oiled by the State highway departments, notably in California and Oregon.

The proportion of mileage surfaced by the bureau is increasing, and it is generally expected that the surfaces will be oiled shortly after completion. The low-cost surface treatment provides a surface which, so far as the comfort of the traveling public is concerned, usually equals hard surfaces of higher type, and it also reduces wear and tear of vehicles. The cost of the treatment is offset in a few years by the reduction in maintenance cost.

Encouraging progress is being made in the construction of forest routes which serve as approaches to the national parks. Construction is nearing completion on the Grand Canyon-Old Trails route

in Arizona, which is the south approach to the Grand Canyon National Park. Similar progress has been made in the construction of the south approach to Lassen Volcanic Park; and the reconstruction of the West Gallatin entrance to the Yellowstone is also approaching completion.

The Gardiner Bridge on the Yellowstone Canyon entrance to Yellowstone Park, which was put under construction during the year, will be opened shortly, and its completion will fill the last gap in the forest-highway approach to the park.

The Columbia Falls-Glacier Park Highway in Montana will be completed this year. This route is of the highest importance to the Glacier National Park and State and interstate traffic. It has been under construction for the past 10 years, and because of the rugged country it traverses the construction has been rather expensive.

Another park-approach road on which very satisfactory progress has been made is the Randle-Yakima Highway in Washington. This route serves Mount Rainier National Park in the same way that the Columbia Falls-Glacier Park route serves Glacier Park.

ROAD CONSTRUCTION IN THE NATIONAL PARKS

Steady progress has been made during the year on the construction of highways in the national parks. This work is supervised by the bureau under an agreement with the National Park Service of the Department of the Interior. The year's work brought to completion 88.7 miles, making the total mileage thus far improved 302.1 miles, all of which is in the system of major park roads which has been designated, including a total of 1,509.7 miles.

At the end of the year construction was in progress on 67.3 miles, of which 20 miles was stage construction.

The mileage included in the designated system in the several parks and the record of completion during the last year and to date are shown in Table 39.

The road construction in the national parks involves some of the most interesting work of the bureau. It is necessarily expensive because of the very rugged country in which it is done and the care that must be observed to avoid marring the landscape.

TABLE 39.—The program of national-park road improvement, and the mileage of roads improved under the supervision of the Bureau of Public Roads

National park	Mileage of the program	Mileage completed under the supervision of the bureau		National park	Mileage of the program	Mileage completed under the supervision of the bureau	
		During the fiscal year 1930	Total to June 30, 1930			During the fiscal year 1930	Total to June 30, 1930
Crater Lake.....	70.5	1.9	23.3	Yellowstone.....	369.2	3.5	23.9
Glacier.....	145.9	2.3	32.5	Zion.....	22.4	4.1	8.7
Mount Rainier.....	122.1	27.7	41.7	Hawaii.....	83.6		11.2
Grand Canyon.....	156.7	25.6	59.5	Mesa Verde.....	47.3	6.0	6.0
Yosemite.....	218.6	8.6	36.5	Acadia.....	4.5		
Sequoia.....	84.5	2.0	25.2	Wind Cave.....	5.4	4.3	4.3
General Grant.....			4.0	Mount McKinley.....	73.5		
Lassen Volcanic.....	39.5	2.7	16.3				
Rocky Mountain.....	64.4		8.7	Total.....	1,509.7	88.7	302.1
Devil's Tower National Monument.....	1.6		0.3				

All park roads serve a heavy traffic during the season, especially on important holidays when the number of vehicles using them amounts to many thousands daily. To eliminate dust and provide adequately for the comfort of those who visit the parks for pleasure and recreation it is necessary that the surface of all roads built be treated with bituminous material as promptly as possible after they are graded. Eventually, it is anticipated that a high type of surface will be needed on all park roads. Until such a surface can be constructed, surfaces of selected local material, oil treated, are the lowest type that can be considered.

The road in Zion Park, recently completed, was dedicated on July 4, 1930. This road, on which there is more than a mile of tunnel with galleries opening through the wall of Pine Creek Canyon, is already one of the country's most famous highways, although few people have yet had an opportunity to see it.

Another road on which there will be a long tunnel—about 4,200 feet in length—is being planned for construction at an early date in Yosemite National Park. The fact that such tunnels are necessary gives some idea of the extreme difficulties of road location in the rugged and almost inaccessible regions now, for the first time, to be brought within the reach of the ordinary traveler.

Of outstanding interest among the projects completed during the past year are the roads to the north rim of the Grand Canyon at Bright Angel Point and Cape Royal. The construction of these roads involved over 25 miles of heavy grading. In Mount Ranier National Park the Paradise section of the Nisqually Road, 8.5 miles long, and the White River Road, nearly 5 miles in length, have also been completed. The former is the southwest entrance to the park and the latter is the approach from the northwest. Both were very heavy pieces of construction. In the Yellowstone, the East Entrance-Sylvan Pass Road has been completed, a road 3.5 miles long. These roads are important as the means of developing and giving access to points of great beauty in the hitherto isolated portions of these great national playgrounds.

Not the least of the interesting features of the national-park roads are their bridges, all of which are designed to harmonize with the natural surroundings.

The Happy Isles bridge in Yosemite National Park was completed during the past year. This bridge—the sixth major structure built by the bureau—is a strikingly beautiful stone-faced concrete arch. The Swift Current Creek bridge on the Babb-Many Glacier route is another important structure completed during the year. Because of the unsatisfactory bids received for this bridge, construction was undertaken by the day-labor method under the bureau's supervision, and the work was completed, in spite of severe weather conditions and other difficulties, by the opening of the park season this year.

The designs of these bridges and, in fact, all of the work done on the national-park roads, are subject to the approval of the Park Service, which is at all times alert to preserve and develop the natural beauty of the extraordinary regions in which they are built.

RESTORATION OF FLOOD-DAMAGED ROADS

By several acts since 1928 Congress has authorized and made appropriations for the relief of a number of States as a reimbursement or contribution in aid from the United States, induced by the extraordinary conditions of necessity and emergency resulting from the unusually serious financial losses to such States through damage to or destruction of roads and bridges by floods in 1927 and 1929.

The first of these acts—that approved May 16, 1928—appropriated a total sum of \$5,197,294 in three parts, as follows: For the State of Vermont, \$2,654,000; for New Hampshire, \$653,300; for Kentucky, \$1,889,994. These appropriations were made available for expenditure by the State highway departments, with the approval of the Secretary of Agriculture, for the restoration and relocation of roads and bridges damaged or destroyed when the State has made available a like sum from State funds for the purpose. In these States the Federal appropriation is expendable only upon work undertaken with the approval of the Secretary of Agriculture after the passage of the act.

The acts since passed providing for similar relief of other States permit the expenditure of the sums appropriated either to reimburse the States for a portion of expenditures made before the passage of the acts or to assist them in work subsequently undertaken with the approval of the Secretary of Agriculture. In every case it is necessary that the State shall have expended or made available for expenditure State funds in an amount equal to the Federal reimbursement or contribution.

The several acts making such provision, the States benefited, and the amount of the Federal appropriation for each are as follows:

The act approved February 28, 1929, appropriated for reimbursement or aid to the State of Missouri, \$258,418; to Mississippi, \$628,000; to Louisiana, \$967,582; and to Arkansas, \$1,800,000.

The act approved March 26, 1930, appropriated for reimbursement or aid to Alabama the sum of \$1,660,000 previously authorized, less 2½ per cent for Federal administration.

The act approved July 3, 1930, appropriated for reimbursement or aid to the States of Georgia and South Carolina the amounts previously authorized as follows: Georgia, \$506,067.50; South Carolina, \$805,561; in each case less 2½ per cent for Federal administration.

As required by these acts, rules, and regulations for carrying out their purposes have been promulgated by the Secretary of Agriculture.

The amounts of the several appropriations (less the 2½ per cent allowed for Federal administration in the case of Alabama, Georgia, and South Carolina), the amounts paid to the States up to June 30, 1930, and the unobligated balance for each State are shown in Table 40. The amounts paid during the past fiscal year are reported in Table 41.

The mileage of road improved during the fiscal year and the corresponding total cost and Federal payment are given in Table 42; and similar information with reference to all improvements completed up to June 30 is given in Table 43, while Tables 44 and 45 give similar data with respect to the flood-relief roads under construction and approved for construction on June 30, 1930.

TABLE 40.—*Flood relief appropriated, amounts paid to States, and the unobligated balance of the appropriation on June 30, 1930*

State	Appropriated	Paid to the States to June 30, 1930	Unobligated balance
Vermont.....	\$2, 654, 000. 00	\$2, 490, 742. 00	\$33, 376. 39
New Hampshire.....	653, 300. 00	563, 345. 89	45, 301. 04
Kentucky.....	1, 889, 994. 00	393, 595. 65	1, 327, 384. 62
Total.....	5, 197, 294. 00	3, 447, 683. 54	1, 406, 062. 05
Arkansas.....	1, 800, 000. 00	-----	1, 719, 403. 62
Louisiana.....	967, 582. 00	-----	967, 582. 00
Mississippi.....	628, 000. 00	341, 702. 91	282, 582. 61
Missouri.....	258, 418. 00	-----	258, 418. 00
Total.....	3, 654, 000. 00	341, 702. 91	3, 227, 986. 23
Alabama.....	1, 618, 500. 00	-----	1, 337, 716. 29
Georgia.....	493, 416. 00	-----	493, 415. 81
South Carolina.....	785, 422. 00	-----	785, 421. 98
Total.....	2, 897, 338. 00	-----	2, 616, 554. 08
Grand total.....	1, 748, 632.	-----	7, 250, 602. 36

TABLE 41.—*Flood relief paid to the States during the fiscal year 1930*

Vermont.....	\$836, 095. 47
New Hampshire.....	456, 203. 99
Kentucky.....	238, 259. 12
Total.....	1, 530, 558. 58
Mississippi.....	341, 702. 91
Grand total.....	1, 872, 261. 49

TABLE 42.—*Total cost, flood relief, and mileage of roads improved during the fiscal year 1930*

State	Total cost	Flood relief	Mileage
Vermont.....	\$3, 765, 044. 36	\$1, 634, 157. 61	36. 7
New Hampshire.....	592, 130. 03	291, 976. 21	16. 9
Kentucky.....	706, 684. 22	325, 200. 44	39. 0
Total.....	5, 063, 858. 61	2, 251, 334. 26	92. 6
Mississippi.....	7, 428. 96	¹ 345, 417. 39	. 3
Total.....	5, 071, 287. 57	2, 596, 751. 65	92. 9

¹ \$341,702.91 represents a reimbursement to the State for work completed prior to the flood relief act.TABLE 43.—*Total cost, flood relief, and mileage of roads improved to June 30, 1930*

State	Total cost	Flood relief	Mileage
Vermont.....	\$5, 507, 928. 24	\$2, 492, 941. 31	57. 8
New Hampshire.....	1, 224, 175. 61	607, 998. 96	24. 6
Kentucky.....	706, 684. 22	325, 200. 44	39. 0
Total.....	7, 438, 788. 07	3, 426, 140. 71	121. 4
Mississippi.....	7, 428. 96	¹ 345, 417. 39	. 3
Total.....	7, 446, 217. 03	3, 771, 558. 10	121. 7

¹ \$341,702.91 represents a reimbursement to the State for work completed prior to the Flood Relief Act.

TABLE 44.—*Total cost, flood relief, and mileage of roads under construction on June 30, 1930*

State	Total cost	Flood relief	Mileage
Vermont.....	\$299, 826. 60	\$127, 682. 30	3. 5
New Hampshire.....			
Kentucky.....	322, 512. 35	155, 655. 44	18. 5
Total.....	622, 338. 95	283, 337. 74	22. 0

TABLE 45.—*Total cost, flood relief, and mileage of roads approved for construction on June 30, 1930*

State	Total cost	Flood relief	Mileage
Kentucky.....	\$194, 267. 73	\$81, 753. 50	10. 8
Arkansas.....	3, 854. 29	1, 927. 14	
Total.....	198, 122. 02	83, 680. 64	10. 8

The mileage of the several types of flood-relief roads completed in the several States during the fiscal year 1930 is given in Table 46; and the total mileage completed, under construction, and approved for construction on June 30, 1930, classified by types and by States, is given in Table 47.

TABLE 46.—*Mileage of the various types of flood-relief roads completed during the fiscal year 1930*

Type of construction	Vermont	New Hampshire	Kentucky	Mississippi	Total
Graded and drained.....			38. 8		38. 8
Gravel, untreated.....	2. 4				2. 4
Gravel, treated.....	9. 1	2. 2			11. 3
Macadam, treated.....		2. 7			2. 7
Bituminous macadam.....	3. 6				3. 6
Portland cement concrete.....	17. 5	12. 0		0. 3	29. 8
Bridges.....	4. 1		. 2		4. 3
Total.....	36. 7	16. 9	39. 0	. 3	92. 9

TABLE 47.—*Mileage of the various types of flood-relief roads completed, under construction, and approved for construction, June 30, 1930, in Vermont, New Hampshire, Kentucky, and Mississippi*

Type of construction	Vermont		New Hampshire (completed)	Kentucky			Mississippi (completed)
	Under construction	Completed		Approved for construction	Under construction	Completed	
Graded and drained.....				10. 6	18. 4	38. 8	
Gravel, untreated.....	0. 8	6. 3					
Gravel, treated.....		9. 1	5. 1				
Macadam, treated.....			2. 7				
Bituminous macadam.....	2. 6	3. 6	2. 3				
Portland cement concrete.....		32. 6	13. 9				0. 3
Bridges.....	. 1	6. 2	. 6	. 2	. 1	. 2	
Total.....	3. 5	57. 8	24. 6	10. 8	18. 5	39. 0	. 3

MOUNT VERNON MEMORIAL HIGHWAY

Construction work on the Mount Vernon Memorial Highway was begun in September, 1929, under a contract for the placing of a riprap sea wall to protect the section of the highway to be built on made land in the old bed of the Potomac River from Columbia Island to the railroad bridge, the construction of a cofferdam, and the supply of stone for bridge facing, at the price of \$96,610.

Provision for the construction of this highway from Washington to Mount Vernon as a memorial to George Washington was made by the act of Congress, approved May 23, 1928, which authorized the United States Commission for the Celebration of the Two Hundredth Anniversary of the Birth of George Washington to survey, select, construct, and maintain the road, in cooperation with the Secretary of Agriculture.

At the request of the commission surveys of two alternate routes were made by this bureau during the fiscal year 1929, and on January 24, 1929, the commission selected the location known as the river route, which extends from the Arlington Memorial Bridge at Columbia Island along and close to the Virginia shore of the Potomac, a distance of 15½ miles to the Mount Vernon estate.

The preparation of detailed plans for the construction was well advanced at the beginning of the fiscal year 1930, and during the year all plans for grading and incidental drainage structures, for the major bridges, and other features necessary for the rapid prosecution of the work have been completed.

The beginning of the first work, mentioned above, was followed shortly by the negotiation of an agreement with the Corps of Engineers, United States Army, under which that branch of the military service undertook to construct approximately 2¼ miles of hydraulic fill in five sections at actual cost which is estimated as \$900,000. Rapid progress has been made in this phase of the construction, and at the close of the year four of the five fills had been completed, and the fifth was under construction. Great credit is due the Corps of Engineers for the celerity and high efficiency with which this work has been performed and the excellence of the resulting fills.

The contract for approximately 12½ miles of dry-land grading and small drainage structures and incidental construction was awarded in March, 1930, at a price of \$435,890.60, and at the close of the fiscal year this work was making very satisfactory progress.

Work on the construction of the major bridges, of which there are 12, including the important highway grade-crossing elimination structure at the south end of the existing Potomac River highway bridge, was begun under a contract awarded in April, 1930, calling for the erection of these structures at a cost of \$1,777,027. At the end of the fiscal year work had been begun and was well advanced on several of these structures.

The paving of the road, which will follow the completion of the grading as closely as the time necessary for the settlement of the fills will permit, will be undertaken under another contract to be advertised shortly after January 1, 1931, and it now appears to be reasonably assured that the road will be ready for opening in connection with the celebration of the bicentennial in 1932.

The road as planned will have a minimum pavement width of 40 feet on a minimum right of way of 200 feet except through the city of Alexandria, Va.

Special attention has been given to the development of interesting alignment, and the long, easy curves, fitted to the natural contour of the land, are outstanding features of the design. With the aid of a landscaping scheme which has been carefully studied the road will appear when completed as a natural part of the countryside. The scars of construction, which detract from the pleasure of driving over many new roads, will be carefully obliterated on this highway.

All important crossroads will be carried under or over the highway on grade-separating bridges, and minor roads intersecting at grade will enter the highway from the two sides at points separated by a considerable distance so as to avoid direct crossing of the principal line of traffic.

Features of the plan which are of more than usual interest are the "clover-leaf" highway grade separation structure at the south end of the existing highway bridge over the Potomac at Washington; the large terminal circle and concealed parking areas at Mount Vernon; and the flared and divided roadways which at suitable points have been provided to facilitate turning and halting of vehicles to permit visitors to enjoy views of the river and distant Washington.

INTER-AMERICAN HIGHWAY

The Sixth International Conference of American States, held at Habana, Cuba, recommended, by resolution, to the Pan American Congress of Highways, which met at Rio de Janeiro in August, 1929, the consideration and adoption of agreements looking to the construction of a Pan American highway connecting North America, Central America, and South America.

By joint resolution, approved May 4, 1928, the United States Congress, taking cognizance of the above-mentioned resolution, requested the President to direct the several agencies of the Government to lend such cooperation and assistance as might be feasible and appropriate with a view to having the matter of the proposed highway thoroughly considered by the approaching Pan American Congress.

By another joint resolution, approved March 4, 1929, Congress authorized the appropriation of \$50,000 to enable the Secretary of State to cooperate with the several Governments members of the Pan American Union in reconnaissance surveys to develop the facts, and to report to Congress as to the feasibility of possible routes, the probable cost, the economic service, and such other information as would be pertinent to the building of an inter-American highway or highways.

At the Pan American Congress of Highways, to which the question had been referred for consideration, the United States was represented by an official delegation, which joined with the delegates of other American States represented in commending to the several Governments the importance of suitable international highway connections.

Following the Congress at Rio de Janeiro, the United States was also represented by a delegation appointed by the Secretary of State

at an inter-American highway conference called by the Government of the Republic of Panama which met at Panama from October 7 to 12, 1929. At this conference a resolution was adopted recommending the creation of an inter-American highway commission to carry on the work of determining the most feasible route of an inter-American highway, and to take such other steps and make such recommendations as will contribute to the realization of the project.

In accordance with the terms of this resolution, the Governments of Costa Rica, Guatemala, Panama, and Salvador have designated representatives on the proposed commission; but the Government of the United States has not yet complied.

However, the Governments of Guatemala and Nicaragua have expressed through the Director of the Pan American Union and the diplomatic missions of the United States a desire to have a reconnaissance survey undertaken to determine the most desirable route for an inter-American highway across their respective territories, and have thus complied fully with the conditions of the joint resolution authorizing an appropriation to enable the United States to cooperate in such an undertaking.

Accordingly, the authorized appropriation was made by act of Congress approved March 26, 1930, and the Secretary of State has designated, with the approval of the President, a technical committee consisting of three engineers of this bureau to cooperate with the Governments of Guatemala and Nicaragua in the surveys requested and with such other Governments members of the Pan American Union from which similar requests may be received.

Late in June, 1930, the members of this committee sailed for Panama, where headquarters have been provided through the courtesy of the Panamanian Government; and the requested surveys in Nicaragua and Guatemala will be undertaken at once under the immediate direction of this bureau in compliance with the orders of the Secretary of State.

SIXTH INTERNATIONAL ROAD CONGRESS

At the invitation of the United States Government, the Sixth International Road Congress will be held in Washington from October 6 to 11, 1930. The congress will be the sixth meeting of the Permanent International Association of Road Congresses, an association in which the United States holds membership as a contributing Government.

Appropriations amounting to \$55,000 have been made by Congress to defray the expense of the Washington sessions, and the Secretary of State has appointed an American organizing commission to make the necessary arrangement.

During the past fiscal year this bureau has cooperated with the commission appointed in every proper way in order to assure the success of the congress, which is expected to bring to the United States a large number of highway engineers of foreign countries for a discussion of road problems of mutual interest and concern to all countries.

HIGHWAY-TRANSPORTATION INVESTIGATIONS**WESTERN STATES TRAFFIC SURVEY**

The survey of traffic on the Federal-aid highway system in 11 western States, to which reference was made in the last annual report, was begun in most of the States in September, 1929. In a few the counts were not begun until October. It will be continued in all of the States for a complete year.

The States in which the counts are being made are Washington, Oregon, California, Idaho, Nevada, Utah, Arizona, Wyoming, Colorado, New Mexico, and Nebraska. In each State the work is being done in cooperation with the State highway department.

The results of this survey, when analyzed, compiled, and mapped, will provide accurate information with regard to the flow of traffic on the main roads of nearly the entire western half of the United States. As such information forms the essential basis of a thoroughly national plan of highway improvement it will be an invaluable guide in the administration of Federal-aid road construction in the future. No such completely coordinated information with respect to the traffic in such a broad area has been available previously in any part of the United States, and it is hoped that the demonstration of the practicability of obtaining it and its usefulness as an aid in the determination of the type and character of future road improvements will lead to the formulation of a plan by which similar data may be obtained and annually revised throughout the United States.

In addition to supplying data with regard to the total density of traffic in all parts of the Federal-aid system within the area, the Western States survey will also furnish much valuable information in regard to the types of vehicles that compose the traffic, whether passenger automobiles, trucks, or busses, the number of persons transported by the passenger-carrying vehicles, the number of common-carrier trucks and busses, the origin and destination of all vehicular movements, and in each State the percentages of interstate and intrastate traffic.

MICHIGAN TRAFFIC SURVEY

Toward the close of the fiscal year arrangements were completed for another type of traffic survey to be made in Michigan in cooperation with the State highway department of that State.

This survey, which is to begin with the opening of the new fiscal year, will have for its principal object the determination of several facts with regard to the character and distribution of traffic on State and local roads and city streets which may have a bearing upon the future distribution of the cost of road improvement within the State.

The survey on the rural roads, which will be continued for a whole year, will cover all roads of both State and local classification in selected representative townships in each county of the State. The principal object of this part of the survey will be to determine, with respect to both State and local roads in each county, what part of the traffic that uses them originates within the county and what part comes from without the county borders. Such a classification of the vehicles can be conveniently made in Michigan by simply noting

certain significant figures of the license numbers carried by all vehicles, since the numbers are assigned according to a code which makes identification of the county in which the owner of each vehicle resides a simple matter.

By employing this means of identification it will be possible to determine what part of the traffic on the roads in each county originates within the county and what part comes from without the county.

It is known from observations made in many States that the traffic generally to be found on a State highway system, made up of the main intercity roads, is a comparatively far-ranging traffic, and that it is composed for the most part of city-owned vehicles. On parts of the State highway system within any particular county it is known in a general way that a large part of the traffic comes from cities within or outside of the county and much of it from without the county. Although there have been few accurate determinations of the character and source of traffic on local roads in any State, it is generally assumed that the roads of this class in the great majority of counties serve a traffic that is predominantly of intracounty origin.

This difference, believed to exist between the origin of the traffic on State and local roads forms the ethical basis of the different measures provided for the financing of State and local road improvement. In all States the State road improvements are supported in the main by funds derived from State taxes, to a large measure taxes on motor vehicles and their fuel. The improvements of local roads are quite generally financed with local funds raised mainly by the taxation of property within the county or other local taxing unit, supplemented to a limited extent by State aid or a share of the motor-vehicle revenue.

In recent years, however, there has been an increasing demand by county and township officials and the representatives of rural precincts in the State legislatures that a greater portion of the State collected revenue be applied to the improvement of local roads. Such demands are usually predicated upon the assumption that the local roads are required to serve a considerable traffic from outside the local taxing jurisdiction and that the State as a whole should compensate the local government in greater measure for the highway service thus afforded to other than local vehicles.

Such a claim is now being pressed in Michigan, and the purpose of the survey is to ascertain the facts that will indicate whether there is reasonable and equitable basis for it.

To provide a similar basis for legislative action on the appeal of the cities which also claim a share of the State revenue in consideration of the use of their streets by rural vehicles, a special intensive survey will be made at the close of the count on the rural roads in seven representative cities of the State. The purpose of this survey will be to ascertain the relative use of the city streets by vehicles owned within and outside of the several cities.

STUDY OF COMMON-CARRIER TRUCK AND BUS OPERATION

In cooperation with the Bureau of Foreign and Domestic Commerce of the United States Department of Commerce an investigation of the use of the highways by common-carrier trucks and

busses was begun during the fiscal year. Certain general information with regard to such operations has already been obtained by means of a questionnaire addressed to a large number of operators.

This will be supplemented during the ensuing year by information in greater detail to be obtained by personal solicitation from a smaller number of representative concerns.

The purpose of this investigation is to develop information with regard to the costs of such operation, especially the influence upon such costs of the condition of the roads, the regularity of the service, the types of vehicles employed, the loads carried, the extent to which the service competes with and supplements rail and water common-carrier service, and other facts desirable and necessary as a basis for the provision of adequate highway service and the equitable and reasonable taxation and regulation of the highway common carriers.

HIGHWAY TRAFFIC CAPACITY INVESTIGATION

In the latter part of the fiscal year the bureau entered into a cooperative agreement with the University of Maryland under which the two agencies will conduct an investigation to determine the volume of traffic that can be economically served, without congestion, by roadways of various widths under a variety of conditions.

It is expected that this investigation, which is being conducted in a number of Eastern States and will be completed during the next fiscal year, will establish a usable relation between the volume of traffic and the width of roadway required to serve it. It will also supply important information in regard to the effect of crossroads, railroad crossings, traffic lights, electric-railway loading platforms, and other obstructions to the free flow of traffic.

STUDIES OF HIGHWAY-PRODUCTION PROBLEMS

The studies of highway-construction operations and equipment and the management of construction work have been continued along the lines developed and reported in previous years. They have a dual purpose: (1) To develop and prove the various possibilities of enhancing the efficiency of road-construction operations of all kinds, and (2) by repeated demonstration of these possibilities on all kinds of work in all parts of the country, to disseminate a knowledge of the more efficient methods and promote their adoption in road-construction work generally.

The latter purpose is achieved in several ways. The contractors with whom the bureau cooperates acquire a knowledge of the methods employed in analyzing the various operations, detecting losses and waste motion, and ascertaining the changes and adjustments of plant and working force needed to improve efficiency. The better methods of operation developed by the demonstrations invariably become the standard practice of these contractors in their subsequent work.

While the number of contractors with whom the bureau can cooperate thus directly is limited, the benefits of the studies are extended to a constantly increasing number of the most progressive road builders by means of the published reports and by papers presented by representatives of the bureau at meetings of contractors and highway engineers. The various associations of contractors

have manifested a keen interest in all phases of the work and have made it the subject of discussion at many of their meetings.

Disseminated in these ways, the influence of the studies is apparent in much of the current road work conducted in all parts of the country, and their influence may be expected to extend in ever-widening circles in the future as a result of the impressions now being made upon the minds of the young men of the on-coming generation of engineers and contractors.

The results of the studies have been incorporated in college textbooks, and the original reports of the bureau are used as texts in many of the schools. Engineering students are thus quite generally instructed in the principles of construction efficiency, and to a limited group of selected students each year the bureau provides an opportunity to observe the application of these principles on actual construction work. These young men, chosen at the end of their junior year at college, are given temporary appointments as student engineers in the bureau and are assigned as assistants in current production studies. Those who manifest aptitude for the work and wish to continue in highway engineering as a profession are reappointed permanently when they have received their degrees and again assigned to the production studies for a further training period of about two years. Many of these young men remain with the bureau and are placed in higher positions in the service as opportunity offers. Others accept positions with State highway departments or with contractors.

The production studies are conducted on selected construction projects of all types in all parts of the United States. As an instance of the success often met with in the work there may be cited a job in southern California recently studied by an engineer of the bureau for a period of about nine weeks.

Two shovels were employed on this job, which was well above the average in respect to management and personnel. One of the shovels was new and manned by an exceptionally experienced crew, while the other had had two years of use and was manned by a less expert crew. As the material in which the shovels worked was practically the same throughout the studies, changes in the rates of production can not be ascribed to differences in material.

Studies were made on both shovels, and as the causes which were holding down production became apparent, suggestions were made to the management as to how they might be reduced or eliminated. The results were most gratifying. For the second shovel—the older one—the average rate of production during the first three weeks was 65, 91, and 106 cubic yards per working hour, respectively, an average of 87 cubic yards per working hour during the whole period, and a progressive increase during each week. But the improvement did not stop here. The studies and suggestions for still further increases in the rate of production were continued during the following five weeks, with the result that during the last three weeks the average rate of production reached 109, 120, and 123 cubic yards per working hour, or an average of 117 cubic yards per hour for the last three weeks, as compared with 87 cubic yards per hour during the first three weeks of the studies. This represents an increase of over 34 per cent in the average rate of production as between two equal and

fairly comparable periods, due entirely to the elimination of time losses and waste motion, the better coordination of dependent operations, and the proper training of the personnel.

The other shovel—the new one, manned by personnel unusually well trained and experienced—started with a higher rate of production, yet it was still possible by careful study and close attention to the coordination of operations and elimination of minor time losses to increase the rate materially. Thus during the first three weeks of the studies the average rate of production for this shovel was 115, 158, and 131 cubic yards per working hour, or an average rate of about 135 cubic yards per hour. This is an unusually high rate for the class of material in which the work was done; nevertheless, the average rate during the last three weeks rose to 160, 150, and 156 cubic yards per working hour, or an average of 155 cubic yards per hour for the entire three weeks. This is an increase of about 15 per cent in the average rate of production of a crew already exceptionally well trained and experienced and working under alert, capable management. Daily rates of operation as high as an average of 239 well-filled dipper loads per hour were attained with a $1\frac{1}{4}$ -yard shovel loading into 5-ton trucks.

Not all jobs, of course, have yielded equally gratifying improvement in the rate of production. On the other hand, very few projects have been found on which an increase of 10 per cent or more in the rate of production was not possible without any corresponding increase in the cost of operation.

In the construction of concrete pavements the pace is set by the mixer. Nothing of value is accomplished if materials are delivered to the mixer at a faster rate than they can be converted into concrete, and the placing and finishing operations can not proceed at a more rapid rate than the output of the mixer will permit. The rate of output depends directly upon the time required by the mixer to produce a uniformly mixed batch of concrete. In order to insure the production of satisfactory concrete, the specifications always require a certain minimum mixing time, varying from 60 to 90 seconds and occasionally longer periods. As the prescribed period definitely limits the output of the mixer and the whole construction operation, it is important to ascertain what period of mixing is actually required to produce uniform concrete of good quality.

Accordingly, extensive studies of the effect of the mixing time on quality and unit cost of concrete mixed in standard paving mixers under actual field conditions were begun in 1924. The result of the first four years' work was published in *Public Roads*, volume 9, No. 5. The work has been continued during the past fiscal year, and the studies have now been carried to a point where they show clearly that not only is a 60-second period of actual mixing ample but that on a well-managed job any reduction in longer mixing cycles can be translated into additional production and a corresponding decrease in the unit operating cost. Thus if a well-managed job working under specifications which require a mixing cycle of 75 seconds is regularly producing at an average rate of, say, 40 batches per hour and an operating cost of \$1 per batch, then it may reasonably be expected that if the specifications are changed to permit the use of a 60-second mixing cycle the rate of production will rise to about

50 batches per hour, and the operating cost will drop to about 80 cents per batch.

As a phase of the study of methods of constructing low-cost bituminous roads which is being conducted in cooperation with various agencies, the methods of production analysis previously applied to other types of construction have recently been employed in the study of the methods used in these lately developed types. Some of the operations, such as those of mixing oil and aggregates in place on the road, present problems which had not arisen in connection with any other type of construction. Consequently, standardized equipment was lacking, and various kinds of implements intended originally for other purposes had to be adapted to this new work, often with obvious lack of efficiency. Studies are, therefore, being carried on to determine the most efficient methods of performing the operations which are really necessary to obtain the desired results and the equipment best adapted to perform these necessary functions at the lowest possible unit cost. To date most of the work has been devoted to obtaining definite data on the various methods employed and to studies of the possibilities offered toward increased rates of production and lower operating costs. These studies, however, already indicate that in many lines of this work considerable improvements are possible, especially in regard to a better coordination of dependent operations and a fuller utilization of the productive capacity of the controlling equipment.

During the past year the bureau has assisted several State highway departments in the installation of uniform accounting and statistical procedures designed to supply full and complete records of expenditures and accomplishments in the fields of highway construction, maintenance, and administration. Basically, this work consists of the development of standard definitions of the various activities in which the several State highway departments are engaged and then setting up a system of standardized accounts which will not only fully meet all the accounting requirements of the department and provide in readily available and practical form complete statistical information on any or all desired lines of activity, but will at the same time be adaptable for use in connection with modern bookkeeping and tabulating equipment in order to give a prompt and accurate service at the lowest possible cost. Further development of this work and the adoption of such uniform systems of accounting by the several States will make possible an intelligent comparison of costs of construction and maintenance of roads as carried on in each of the States, a comparison which is not possible at present because of the dissimilar form of the available records. Such comparisons, when they can be accurately drawn, will be helpful to all States as an index of the relative efficiency of their practices and will be especially useful as a means of supplying data not now available with regard to the cost of maintaining the various types of roads under various conditions of traffic, climate, topography, and soil. During the past year expert assistance along these lines was given to the State Highway Departments of Alabama, Georgia, Illinois, Indiana, Oklahoma, South Carolina, and Tennessee.

PHYSICAL RESEARCH

SUBGRADE INVESTIGATIONS

The general problems involved in the subgrade investigations and the complicated nature of these studies have been described in previous reports. During the year these investigations have been continued, as in the past, with the cooperation of the Bureau of Chemistry and Soils and various State highway departments and educational institutions.

Steady progress is being made in the development of new and useful information, and the advance that has been made toward a more accurate conception of the characteristics of subgrade materials as they influence highway construction is very satisfying.

The stability of the subgrade or its ability to resist lateral flow under load, as it is now understood, depends upon two mechanical properties, cohesion and internal friction. Cohesion, that part of the resistance to distortion which is independent of the external pressure acting on the soil, is furnished by the soil particles of small size such as clay and colloids. Internal friction, that part of the resistance to distortion which increases in direct proportion to pressure, is furnished by the larger soil particles such as sand grains. The cohesion of clays varies with the character of the colloids present, and the internal friction developed by sands varies with the angularity and surface texture or roughness of the individual sand grains. This knowledge is important with respect to the design of stable subgrades and low-cost road surfaces such as those of sand-clay and topsoil, since it furnishes a basis for the determination of the relative amounts of sand and clay required to produce stability, depending upon the cohesion and internal friction of the particular materials available.

It is now understood that volume changes in subgrades, in the absence of frost, are caused entirely by absorption of moisture and its loss by evaporation and that there is a minimum limit of moisture content below which the volume of a soil can not change. Above this shrinkage limit the loss in volume of a soil due to loss in moisture content is equal to the volume of the moisture lost. Practically this information suggests that the proper treatment of subgrades likely to be subject to detrimental volume change is to protect them by some means which will prevent the absorption of water and its loss by evaporation.

It has been found that the presence of mica, peat, or other materials which produce a porous soil condition, will result in a subgrade having detrimental elastic properties. Such elasticity may produce failure in pavements of flexible type such as macadam, and excessive early cracking in concrete pavements. The preliminary identification of elastic subgrades is important both from the standpoint of the preparation of the subgrade and the selection of a suitable type of surfacing. For instance, unless an elastic subgrade has been stabilized by treatment, an attempt to construct a macadam surface may result in failure. Also, attempted consolidation with a heavy roller, which is beneficial for a nonelastic subgrade, in the case of an elastic subgrade may result in a rebound after rolling and cause early cracking in newly laid concrete pavements.

Excessive heaving due to frost action is now understood to be due to the formation of well-defined ice layers in the subgrade and is attributed to the following physical phenomena:

(1) The ability of water particles contained in large soil pores to freeze at about normal freezing temperatures.

(2) The ability of water contained in the very small soil pores to resist freezing at abnormally low temperatures.

(3) The ability of the large water particles, upon freezing, to draw to themselves particles of water from the capillary pores which do not freeze at normal freezing temperatures. This water from the capillary pores freezes upon coming in contact with the larger water particles already frozen and adds to the size of the existing ice crystals.

(4) As water is drawn to the growing ice crystals from the capillary pores the supply may be replenished by water drawn up by capillary action from the ground water level. The continuation of this process, under favorable conditions, may cause roads to heave as much as several feet.

It has been found that neither coarse-grained sands nor cohesive clays are associated with detrimental frost heaving. On the other hand, porous silts and porous clays, low in cohesion, are subject to detrimental heaving in the presence of the certain moisture and temperature conditions.

An understanding of the causes underlying the occurrence of frost heaving and the ability to identify portions of the subgrade where heaving is likely to occur are of great practical value. For example, when gravel or other low-cost surfaces are to be constructed on silts or porous clays it may be necessary to provide an expensive drainage system to lower the ground water to an extent which will cut off the supply of water that would cause excessive heaving. In contrast, when these surfaces are to be constructed on cohesive clays, where trouble may be expected more as a result of volume change due to variations in moisture than as a result of frost action, a protection of the subgrade to prevent the entrance of water from above may be more effective than an expensive subdrainage system.

With respect to drainage it is now understood that certain soils, such as heavy clays, can not be effectively drained and that the flow of ground water is through porous layers of soil. Completely to intercept the seepage of ground water, drains must be laid at an elevation corresponding to the elevation of the lower surface of the porous soil layer and the upper surface of the impervious undersoil. The significance of this knowledge with respect to road construction is that drains may be ineffective unless placed at exactly the proper depth and that this depth can be determined only by soil examinations made at every location at which drains are to be installed.

The methods used in classifying and identifying subgrade soils for highway purposes are radically different from those employed by the agronomist in the study of soils for agricultural purposes. The latter is interested primarily in the measurement of the factors which indicate the ability of a soil to nourish plant life. The highway engineer must be able to identify the physical properties which govern stability, volume change, elasticity, frost heaving, and drainage. The identification of these properties by means of simple tests is a new

science. As the progress being made demonstrates more and more the practical value of this work with respect to road construction the greater becomes the number of problems presented for solution.

LOW-COST ROAD INVESTIGATIONS

The development of satisfactory low-cost types of surfacing for light-traffic roads is a matter which will continue to demand the increasing attention of highway engineers. Roads of this character constitute important links in the highway transportation system, and relatively inexpensive improvements which will render them passable at all seasons of the year have become a necessity in many locations. The investigations of the bureau, designed to add to the existing knowledge of this subject, are being continued, and new studies are being undertaken as the conditions warrant.

Several experimental construction projects were described in the report of last year. Of these, the project in California, conducted in cooperation with the division of highways of the California Department of Public Works, involves mixed-in-place treatments and surface treatments of crushed rock and crushed gravel surfaces with different types of bituminous materials. The mixed-in-place treatments were completed during the fall of 1929 and give preliminary indications that some of the hitherto untried materials may prove very effective in this type of construction. Some of the surface-treated sections were completed during the spring and the rest will be completed during the summer of 1930. The publication during the next year of a report describing the materials and methods employed in the various sections is contemplated.

The experimental road in the sand-hill area of Nebraska for the study of bituminous treatments of roads composed almost entirely of sand was partially constructed during the fall of 1929 and the construction will be completed during the summer of 1930. The condition of the sections already completed, together with the observed behavior of the earlier experimental section in this area, now nearly two years old, encourage the belief that an economical type of construction will be developed which will be useful in improving highway conditions in this area and others of similar character.

In South Carolina the construction of different types of bituminous surfacings on marl and sand-clay bases, in an experimental project $4\frac{1}{2}$ miles in length, was completed during 1929. There are now under observation in this State three experimental projects, constructed and maintained in cooperation with the State highway department, having a total length of approximately 32 miles. It is anticipated that progress reports of this work will be published during the next fiscal year.

Preliminary arrangements are being made to extend the study of low-cost road construction to Colorado where, in cooperation with the State highway department, it is proposed to build an experimental section about 3 miles in length. This will have a gravel surface, treated with bituminous materials by the mixed-in-place method. Among other features to be studied will be the possible utility of types of bituminous materials which have not been used before in either ordinary construction or experimental work.

The study of methods of bituminous low-cost road construction developed by State highway departments and local authorities in various parts of the country, begun during the preceding fiscal year in cooperation with the asphalt institute, have been continued throughout the past year. These methods have been developed to meet conditions prevailing in the particular localities, with results more or less satisfactory. Many of them have much in common but differ in details regarded as of importance by the local authorities. By studying and comparing them the bureau and its cooperators hope to be able to weigh the relative advantages of each method, to gain a first-hand knowledge of the variable conditions that must be dealt with, and to obtain suggestions here and there which, when combined, will lead to the development of more effective methods than have yet been developed. The definite ideas with respect to new and potentially valuable methods and materials, developed as a result of these broad studies of prior experience will be subjected to intensive study and test in the laboratory and in experimental roads to be constructed subsequently under carefully controlled conditions.

During the past year such broad studies have been made of methods of bituminous treatment of sand-clay and topsoil roads developed in Florida and South Carolina, of the oil treatment of earth roads as practiced in Illinois, and the so-called retread method of restoring worn stone and gravel roads as employed in Indiana. A report of the Florida and South Carolina investigations has been published.

During the ensuing year it is planned to continue with studies of the process developed in Minnesota and known as the gravel-blotter method, by which remarkably satisfactory improvements have been made at very moderate cost; and the study of retread types will be extended into Kentucky, where the method employed differs in a number of particulars from that used and previously studied in Indiana.

MOTOR-VEHICLE IMPACT INVESTIGATIONS

For a number of years the bureau has been investigating the impact of motor vehicles (particularly motor trucks of the heavier types) as a force destructive of road surfaces. Much of this work has been done in cooperation with the Society of Automotive Engineers and the Rubber Manufacturers Association.

These investigations have been of a pioneer nature and have led, of necessity, to the devising of instruments and apparatus for the determination of the forces involved.

In order that the accuracy of the data, obtained with these devices, might be definitely established an arrangement was made with the Bureau of Standards for a cooperative investigation of the accuracy of all the instruments which had been used or proposed for use in this work. A very searching study was made and during the past year was completed.

The report of this instrument investigation has cleared away all uncertainty regarding the limitations of the instruments, has established the probable accuracy of future work, has allowed the release of completed reports and the resumption of active investigation along lines previously authorized.

Three reports have been prepared for early publication. The first is a summary report of the instrument investigation, with special emphasis on the relation of this work to the other data on motor-truck impact. The second report discusses the effect of the thickness of the tread rubber of solid and cushion truck tires on the magnitude of the impact reaction which may be expected, and the third is an account of a study of the interrelationship of the four major variables which determine the magnitude of the impact reaction. These four variables are wheel load, tire equipment, vehicle speed, and road roughness. The third report presents data showing how each of these important factors is related to the other.

INVESTIGATIONS OF CONCRETE

A number of investigations of Portland-cement concrete, to which reference has been made in previous annual reports and from which it is hoped to obtain a more complete knowledge of how to use this important structural material in highway work, have been continued. These investigations include studies of the most desirable proportions of materials to use in concrete-pavement mixtures, with special reference to the effect of increasing the amount of coarse aggregate; studies of conditions affecting the resistance of concrete to repeated frost action, with special reference to the influence of the kind of aggregate used; an investigation of sands used in concrete-pavement construction for the purpose of ascertaining the influence of the type of sand on the quality of concrete; and studies of various methods of curing concrete pavements in an effort to ascertain which, if any, of the numerous methods now being actively promoted are as satisfactory as the present standard method of covering the fresh concrete with a layer of damp earth kept wet for several days.

The half-mile experimental pavement to which reference was made in the report of last year has been constructed, and the tests have been practically completed. Complete analysis of the data has not yet been accomplished; it is probable, however, that concretes containing considerably more coarse aggregate than the mixtures now usually employed may be safely used.

The severe weather conditions to which concrete pavements are subjected, especially in the Northern States, with the consequent tendency to disintegrate through frost action emphasizes the importance of studying conditions affecting durability. Studies of this character are necessarily of long duration on account of the time required to produce conditions in the laboratory which are comparable with actual weathering. For this reason the first series of tests conducted by the bureau along this line, which was started several years ago, is only now being completed. These tests were for the purpose of ascertaining how the resistance of concrete to frost action is affected by the kind of coarse aggregate used. The tests indicate the extreme importance of determining definitely in advance of any construction whether the coarse aggregate to be used is of a durable character. Nondurable aggregates, even though they make concrete of the required strength, should never be used.

During the summer of 1926, 40 concrete test slabs 200 feet long and 2 feet wide were constructed at the Arlington Experiment Farm, Rosslyn, Va., and subjected to a wide variety of curing treatments.

For three and one-half years these sections were closely observed to determine the effects of the various curing methods. Data were obtained on the volume change, moisture loss, surface hardness, and many other characteristics of the several sections. A detailed report of these studies has been published during the past year; the information contained in that report is a distinct contribution to the general knowledge of the subject of the curing of concrete pavements.

The bureau has also cooperated with the Tennessee Department of Highways in a study of curing methods as applied to actual pavements. The investigation, which has been completed recently, was conducted on a 17-mile length of concrete pavement in southwestern Tennessee. Twenty-five different methods of curing were employed. In the report, which is now being prepared for publication, the analysis of the relative efficiency of the various curing methods will be based on a consideration of such factors as the strength of the concrete specimens and transverse cracking and surface hardness of the pavement.

A device, utilized in both of the above curing investigations, has been developed for indicating the surface hardness of concrete pavements. This apparatus is very simple in principle and is portable, so that it may be used on any pavement, the test being made in place without damage to the pavement. The device consists of three hardened steel wheels, bearing a constant load, which are caused to roll slowly around a circular path (20 inches in diameter) on the pavement. These wheels cause a narrow groove to be worn in the pavement and the depth of the groove after the completion of a specified number of revolutions is a measure of the hardness of the pavement surface. The test was devised to indicate the effect of curing treatments on surface hardness but may be used to study other factors, such as aggregates.

HIGHWAY-BRIDGE INVESTIGATIONS

In the last annual report, a program of bridge-floor slab tests being made in cooperation with the Port of New York Authority was described in some detail, and the importance of the tests was noted. These tests have been virtually completed, and a comprehensive report is being prepared. In this program three different aggregates were used, and the concretes were placed by each of four methods. Strength data were obtained for both plain and reinforced slabs. A large number of bond tests of embedded steel were made and information developed on the elastic and other properties of the concrete obtained by the various combinations and methods of placing. There is a demand for information which will assist in the development of bridge-floor slabs of less weight than those ordinarily employed, and the report of this investigation will add materially to the data now available.

Another investigation having a similar purpose is to be carried on during the next fiscal year in cooperation with the authorities of Allegheny County, Pa. A newly developed type of steel and concrete bridge-floor slab of extremely light weight has shown satisfactory strength in laboratory tests under static loads. To observe its resistance to impact forces, such as would be developed by the

wheels of heavy motor trucks, impact tests are to be conducted on an experimental section of bridge floor about 15 feet square.

In France, the Freyssinet method of concrete-arch construction has been in use for some years and has been employed in the construction of some of the longest concrete-arch spans in the world. By means of hydraulic jacks placed at a transverse joint at the crown, the two halves of the arch are forced apart and lifted from the centering which supports the arch ribs during construction. This permits the final placing of the axis of the arch in any predetermined position, thus relieving the structure of certain stresses which would otherwise occur and permitting a more accurate determination of stress effects than is possible in the case of concrete arches constructed by usual methods. The method has never been employed in bridge construction in the United States. During the year arrangements for a detailed investigation of its advantages have been made. This investigation, to be made in cooperation with the Oregon State Highway Commission, will be conducted in connection with the construction of a large concrete-arch highway bridge in Oregon, and will involve accurate measurements of stresses and deflections in the structure. The substructure of the bridge is to be completed during the season of 1930, and the investigational work will be done during the season of 1931 in connection with the construction of the superstructure.

DIVISION OF AGRICULTURAL ENGINEERING

IRRIGATION INVESTIGATIONS

DUTY-OF-WATER STUDIES

Studies pertaining to duty of irrigation water in its various forms continue to occupy a prominent place in the activities of the division of agricultural engineering. The last of a series of five reports on the irrigation requirements of western lands, begun several years ago, is nearing completion. The summation of the water allotments discloses the fact that water is available for the eventual irrigation of 62,000,000 acres, when the Nation needs the products which this acreage would yield.

Where the waters of the San Joaquin River meet those of the Sacramento River in California a broad delta has been created, about half of which has been protected by levees and rendered highly productive by drainage and irrigation systems. Part of the reclaimed area is below tide level and the rest but slightly above. To determine accurately the quantity of water transpired by cultivated plants on this area it is necessary to grow specimens of each kind in tanks. The native vegetation, such as tules and cattails, which flourish on the unreclaimed areas, has likewise been subjected to similar treatment with rather remarkable results. The records for 12 tanks in which such vegetation was growing show that for the month of August, 1929, alone the average water loss resulting from evaporation and transpiration was at the rate of 2.65 acre-feet per acre. About 8,000 acres are occupied by this worthless growth, and the quantity of water evaporated and transpired from them annually is estimated to be 150,000 acre-feet—sufficient to irrigate adequately at least 60,000 acres of alfalfa.

In southern Oregon the water requirements of pear trees are being determined by ascertaining the relationship between water applied and yield, the moisture content of the soil before and after irrigation, and how water can be made to penetrate heavy soils in order to furnish much-needed moisture to the lower roots.

In southern California a diminution of the available water supply following a series of dry years has aroused a widespread and intense interest in everything pertaining to water. A number of State and Federal agencies have entered this field in an endeavor to contribute aid. The work of this bureau is being carried on along two more or less distinct lines. In one of these an intensive study is being made of orchard irrigation with the object of eliminating much of the customary waste and applying water more effectively and in better time, so as to produce a profitable yield of fruit with less water. The other is more general in character and consists in collecting data to show what becomes of the rain which falls on untillable watersheds sparsely covered by native vegetation. Rainfall penetration in soils and subsoils is being studied as well as the quantity of rain water annually transpired by native vegetation.

For a few years past the precipitation has been subnormal, and very little water falling as rain upon the valley floors in southern California has penetrated within the soil to depths below the roots of plants. As a result the level of the underground water, which forms a supply for pumping, has been lowering and additional means of replenishment have been sought.

WATER SPREADING

In many sections of the West a considerable part, and in some sections the major part, of the irrigation-water supply is derived from underground sources and is elevated by means of pumps. The recent cycle of dry years has resulted in an overdraft upon the underground-water supply and a consequent lowering of the water table. In some cases the economic limit of pumping lift has almost been reached. Near the coast the water table is at or near the ocean level, and unless some means of increasing the underground-water supply or decreasing the demand on this supply is employed, salt water will come in from the ocean and impair the quality of underground water to such an extent as to render it valueless for agricultural purposes.

The results of rainfall-penetration studies have disclosed certain facts regarding the rate of replenishment from this source to the underground-water supply, and to augment this replenishment the attention of this bureau and other agencies has been directed toward the spreading of flood waters over porous areas associated with underground-water basins.

Study of the problem of water spreading and its effectiveness has just been undertaken, but the practice in southern California dates back more than 40 years. The results of the preliminary investigational work promise much for this method of increasing the present available water supply in many Western areas.

LOSS OF WATER BY EVAPORATION

A report giving the results of research investigations of the factors affecting rates of evaporation from a free-water surface has been

submitted for publication. A reservoir has been found that is geologically "tight" and has an inflow during the summer season that can be accurately measured and an outflow that can be controlled. Plans have been made to carry on intensive evaporation studies upon it.

PUMPING FOR IRRIGATION

There are many faulty installations of pumping equipment, and it is not infrequent to find the water elevated appreciably higher than necessary, thereby adding to the power cost. While much time and means have been devoted to the improvement of pumping equipment, too little attention has been paid to the economical utilization of the water, and frequently wasteful usage by the irrigator more than offsets mechanical betterments.

During the last year or two it is probable that more land in the western part of the United States has been drained by pumping than by gravity. Where conditions are favorable to pumping, that method is more satisfactory than gravity drainage, largely because it is possible to lower the general water surface of the underground water to a greater depth and at much less expense by means of pumping. Since this means of drainage was first undertaken in the Salt River Valley of Arizona, it has extended into several of the Western States, while in California and Idaho large areas of water-logged land have been reclaimed by this means. In cases where the underground water is suitable for irrigation, the operating expense of the pumping plants is frequently wholly offset by the utilization of the pumped water for irrigation.

CUSTOMS, REGULATIONS, AND LAWS RELATING TO IRRIGATION

Studies begun during the fiscal year 1928 in cooperation with the Oregon Agricultural Experiment Station, involving the engineering, agricultural, and general economic status of various irrigation districts in Oregon, were continued during the past year at the invitation of the State reclamation commission. Reports on several districts begun during the previous fiscal year were completed and submitted to the State reclamation commission, and two additional studies were undertaken. Negotiations are now in progress between most of the districts and the holders of their bonds to effect settlements on bases ascertained in these studies to be economically justifiable. Invitations have been received to undertake similar studies in connection with defaulting districts in several other States.

The field work and manuscript for a revision of Department Bulletin No. 1177, Irrigation District Operation and Finance, were completed during the fiscal year. In connection with this project, a comparative summary, by topics, of the irrigation district laws of all 17 Western States has been undertaken and is nearing completion. This will be submitted for publication during the current year. A technical bulletin, entitled "Commercial Irrigation Companies," was issued during the year.

DESIGN, INVENTION, AND TESTING OF APPARATUS

Studies of the Parshall measuring flume have been continued, especially in connection with the large sizes. Investigations regard-

ing this type of measuring flume have been nearly completed, and a manuscript on large flumes will be prepared for publication during the winter of 1930-31.

Studies were continued on the adjustable-tube measuring device, which is intended for use on small water supplies and for individual use.

FLOW OF WATER IN DITCHES, PIPES, AND OTHER CONDUITS

A bulletin on the flow of water in riveted steel and analogous pipes was issued during the fiscal year.

The study of the flow of water in flumes is being continued, and special attention is being given to "entrance losses." A design for entrances to flume sections has been developed which results in a more nearly straight-line approach of the water to the flume section, thereby increasing the carrying capacity.

RECLAMATION OF ALKALI LANDS

Investigation of this problem in cooperation with the Idaho Agricultural Experiment Station will have continued for a period of five years at the end of the 1930 season. During the fall of 1929 a pumping plant was installed on the experimental tract for the purpose of supplementing the gravity drainage system. This plant has been in continuous operation during the first half of the calendar year 1930. It is expected that a progress report will be prepared for publication at the close of this season.

DRAINAGE OF LANDS OVERLYING ARTESIAN BASINS

For the last three years the bureau, in cooperation with the Utah Agricultural Experiment Station, has been studying methods utilized for the drainage of water-logged lands overlying artesian basins, the particular basin under observation being in Cache Valley, in northern Utah. The artesian basin is generally about 50 feet below the surface, and the soil overlying this basin is for the most part dense material. It was soon found both theoretically and by trial that gravity drainage was not practical. The problem, therefore, became one of relieving the hydrostatic pressure of the underground water, since observation had shown that the land was water-logged by the upward movement of water from this artesian basin. Numerous test wells were driven over a considerable area for the purpose of observing the hydrostatic pressure. A considerable number of 2-inch and 4-inch wells were sunk into the basin, and their effect upon the pressure was observed. There is now in course of construction an 8-foot well that will reach into the underground gravels. There will be installed in this well a pumping unit of sufficient capacity to lower the water in the well to such depth as may be desired, and the effect upon the surrounding observation wells will be determined. It is expected to complete this work during the season of 1930.

SEWAGE IRRIGATION

Distribution of sewage on cropped fields is an important engineering problem that has been under study for the past two years at Vineland, N. J., in cooperation with the New Jersey Agricultural

Experiment Station. Sewage from a population of 8,000 is disposed of on an irrigated farm. Equal division of the effluent into small streams of 20 to 30 gallons per minute each has been effected by laying a 12-inch pipe line fitted with cast-iron outlets. These are all placed at the same elevation, and the discharge is admitted to furrows spaced 3 feet apart. By keeping the furrows unobstructed the sewage travels satisfactorily for a distance of 300 or 400 feet. Sludge, always a difficult problem, is pumped into the effluent from a settling tank and carried for more than a half mile through terra-cotta pipe and open ditch and spread over a specially prepared field, where it is plowed under before the field is planted.

DRAINAGE INVESTIGATIONS

RUN-OFF MEASUREMENTS AND DITCH CAPACITIES

Investigations relative to rates of run-off and channel capacities were continued to January 1 on 10 watersheds and their channels in northeastern Indiana. All equipment was then moved to a location in northwestern Ohio. The Ohio project includes nine watersheds and channels offering great contrast in surface features to the areas previously investigated.

Considerable time has been given to a study of the relationship existing between rates of rainfall and run-off, with regard to watersheds having great range of size. A report of the Indiana investigations which present correlations between these factors that can be used as a basis for computing run-off expectancies has been prepared.

The investigations of the run-off from Ralston Creek, Iowa, a small stream draining an agricultural area of 3 square miles, were continued during the fiscal year in cooperation with the University of Iowa. By means of a weir-control station, nine rain gages, and a water-stage register, accurate information in regard to the relation of run-off to rainfall is being obtained. A report covering the last five years of this study is now being prepared.

OPERATION AND MAINTENANCE OF DRAINAGE PUMPING PLANTS

Studies of drainage pumping plants along the Illinois River and along the Mississippi River between St. Louis and Savanna, Ill., have been continued. Five progress reports have been prepared covering this investigation, and the manuscript for a bulletin based on the investigation is in preparation. It has been found that there is little difference between the average unit costs of pumping with electric power and oil-engine power provided comparisons are based on the pumping of equal quantities of water. The minimum unit costs were obtained by an oil-engine plant which had been built at a very low cost per horsepower. This suggests that greater economy in the construction of the pump house, foundation, and suction bay is desirable in order to reduce the fixed charges. The operating expenses of the steam plants are greater. Many plants of this type have been abandoned since 1920, and others are operated only for emergency pumping. It has been found that the operating efficiency of the plants can usually be improved by better supervision, by more efficient speed regulation, by proper maintenance, or by the substitu-

tion of more economical equipment. Greater pumping capacity is needed in some districts in order to maintain a lower water level and obtain better drainage.

FLOW AROUND BRIDGE PIERS AND OVER EMBANKMENTS

In continuation of studies begun in 1928 on the obstruction of bridge piers to the flow of water numerous experiments were made at the hydraulic laboratory of the University of Iowa, in cooperation with the university, on additional models of various pier shapes. Coefficients were developed for use in hydraulic formulas for computing backwater caused by bridges.

Hydraulic tests on the flow of flood water over full-size sections of single and double track railway and highway embankments were made and coefficients developed for use in hydraulic formulas for computing the quantity of flood water passing over such embankments. The results have been published.

Experiments on the obstruction of single-track pile trestles to the flow of water were made on both a full-size pile trestle and a one-fourth size model. The effect of end abutments was also investigated. Hydraulic-formula coefficients were also derived for use in connection with such structures.

DURABILITY OF DRAINTILE

The bureau, in cooperation with the Department of Agriculture and the department of drainage and waters of the University of Minnesota, has continued the investigations at university farm, St. Paul, relative to the durability of dRAINTILE under exposure to various conditions of soil and climate.

Experiments to show the effect of steam curing of concrete at temperatures up to 350° F. for a wide range of time periods were conducted in considerable detail and conclusions drawn as follows:

(1) Solely from the standpoint of strength, nothing is gained by curing concrete in water vapor at a temperature much above 155° F., and little is gained, even at this temperature, by prolonging the curing period beyond 48 hours.

(2) Solely from the standpoint of resistance to sulphate waters, nothing is gained by increasing the temperature of the water vapor in which concrete is cured until 212° F. is reached. Between 212° and 285° it may now be definitely stated that increased resistance follows increase of curing temperature.

DRAINAGE INDEX OF SOILS

The effort to check the accuracy of the elutriation method of determining the proper spacing of drains has substantiated the belief that the method is safe. It appears that drains placed at a suitable depth and the indicated distance apart for that depth will provide satisfactory drainage. However, it also appears that such spacing may be unnecessarily close and therefore unduly expensive. Because of this fact and because of the known limitation of the elutriation method in dealing with some of the lighter soils that may need drainage, an effort is being made to find a method that applies to both

light and heavy soils and that is accurate in its indication throughout the range of soil types found in agriculture. Several methods that offer promise are now being investigated in the laboratory.

CONTROL OF SOIL EROSION

Observations on the special soil-erosion plots at Raleigh, N. C., were continued. Winter cover crops were found to have only a slight effect in controlling erosion, effecting a reduction of only 10 per cent. Losses of soil from corn and cotton plots when the two crops were grown in rotation were practically as large as when these crops were grown on the same land continuously. Grade of the terrace channel was found to affect run-off from terraced areas considerably.

The appropriation act for the fiscal year 1930 continued the special fund to be expended by the department in making soil-erosion and moisture-conservation investigations. The fund was allotted to the Bureau of Public Roads, the Bureau of Chemistry and Soils, and the Forest Service. The investigations on the soil-erosion experiment farm at Guthrie, Okla., were continued in cooperation with the Bureau of Chemistry and Soils and the Guthrie Chamber of Commerce. During the period April 26 to May 17, 1930, a total rainfall of 11.42 inches was measured at this farm. This is more than one-third of the average annual rainfall at Guthrie. On May 3, 3.22 inches of rain fell in approximately 1½ hours, 1.8 inches falling in 25 minutes, and 0.5 inch in 5 minutes. Thus the maximum rainfall for a period of five minutes was at the rate of 6 inches per hour. Terraces in the red-plains area of Texas, Oklahoma, and Kansas must be designed and constructed to provide for the run-off during periods of such intense rainfall.

One of the outstanding observations made during the storm period was the relative severity of the erosion on the untterraced land where the surface conditions were the same as on the terraced land. New gullies developed in the untterraced land, and wind-blown soil that practically filled many of the old gullies was washed away, while on the terraced land this wind-blown soil was collected and saved by the terraces.

An experiment designed to determine the relative amounts of erosion from terraced channels with falls of 2 and 4 inches per 100 feet, indicated that between four and five times as much soil was carried away on terraces with the 4-inch fall. Terraces without fall (level) and some with a fall of 6 inches per 100 feet were also included in the experiment, but silt-measuring boxes had not yet been installed on these terraces. The results already obtained show that the grade of the terrace has a very appreciable effect upon the amount of soil removed by run-off water and that the grade should be given careful consideration in the design of terraces, not overlooking, however, the necessity for removing the water in time to prevent overtopping the terrace.

Valuable information was obtained from an experiment on the spacing of terraces 700 feet in length on virgin soil and a land slope of about 5 per cent. The intense rain of one-half inch falling in five minutes was a critical test of these terraces. In the channels of terraces with 5-foot spacing the water reached a depth of nearly 17 inches; with 3½-foot spacing the depth was about 14 inches; and in

the channels of terraces with 2-foot spacing the depth reached was about 10 inches. To provide a margin of safety of 6 inches, the above terraces should be built 23, 20, and 16 inches high, respectively. An examination of the ground between the terraces showed that erosion between terraces spaced 5 feet apart was much greater than that which occurred between terraces spaced 2 feet apart.

A series of laboratory tests was made at the hydraulic laboratory at Iowa City on the silt-measuring apparatus developed for use in soil-erosion investigations. The device was calibrated for field use, both the hydraulic and the silt-measuring characteristics and coefficients being measured and computed. The results of measurements made with this device will be given due consideration in conjunction with the run-off in making recommendations for the spacing and height of short terraces on moderate slopes in the red-plains region.

On the experimental farm near Temple, Tex., which is being operated in cooperation with the State agricultural experiment station and the Bureau of Chemistry and Soils, practically all of the land has been terraced, and experiments have been laid out for the purpose of determining the best design of terrace systems for the black-land region of that State. On May 10 a rain of $5\frac{3}{4}$ inches occurred, 5 inches of which fell in about four hours. This intense rain caused breaks in one set of terraces, but the damage was due to the silting of the intercepting ditches that had been constructed to provide for the removal of run-off water from outside the area. These ditches have since been enlarged and protected against silting, and no further difficulty is anticipated. No appreciable erosion occurred on the terraced fields, whereas on adjacent unterraced land it was very severe. Observations made after the heavy rain of May 10 showed that on land in corn and cotton, level terraces from 400 to 1,400 feet long with one end open had withstood the test very well, and examination a few hours after the storm ended showed that the water which collected behind the terraces disappeared rapidly. The fact that level terraces on cotton and corn land withstood the storm satisfactorily is rather surprising and appears to indicate that such terraces may be practicable in the black-land area. However, additional records should be obtained before definite recommendations are warranted.

Upon the completion of the construction of the terraces and the planting of the crops the installation of the scientific equipment was started and should be completed early in the fiscal year 1931.

In August, 1929, additional experiments were begun at the Fort Hays Experiment Station in cooperation with the Kansas Agricultural Experiment Station and the Bureau of Chemistry and Soils. A survey and map of the farm has been made and other preliminary work has been done. About 60 acres of comparatively level land has been terraced and about 20 acres has been deep tilled to determine the effect of such work on moisture conservation. Altogether about 100 acres of land has been prepared for experimental work, and the necessary scientific equipment has been installed.

Additional farms have been established near Tyler, Tex., in cooperation with the Texas Agricultural Experiment Station; near Bethany, Mo., in cooperation with the Missouri Agricultural Experiment Station; and near Statesville, N. C., in cooperation with the

North Carolina Department of Agriculture and the North Carolina Agricultural Experiment Station. Surveys and maps of the Tyler and Bethany farms have been completed and other preliminary work has been done. The survey of the Statesville farm was in progress at the close of the year.

Practically all farming operations on the experimental farms are being done with modern farm machinery and a thorough study is being made of the operation of such equipment over terraced land. It has been discovered that some of the machinery that proves satisfactory for ordinary conditions is not flexible enough for operation over terraces and that some changes in design will be required if it is to be used successfully in regions where terracing is widely practiced.

FARM MACHINERY

CORN-BORER CONTROL

In the plow studies special emphasis has been placed on attachments to aid in producing better coverage of stalks. The scraping trash shield of floating type, which aids in effecting practically complete trash coverage, has been developed as a result of these studies. Three manufacturers have made especially shaped plow bottoms according to designs dictated by field tests.

A 3-row stalk shaver attachment has been developed for use on a single-row corn cultivator. This implement is light in draft, easy to maneuver, and performs satisfactorily. A 4-bar side-delivery rake fitted with specially constructed flexible teeth has been built for windrowing cornstalks. Field tests show that it does a very clean job of raking.

Work is in progress on stalk loaders. The rake-bar type and the combination cylinder and rake bar type of hay loader, after considerable alteration to meet the requirements, have given encouraging results in preliminary trials. Further studies have been made of baled whole and shredded stalks to note the effect of different baler pressures on borer mortality and also the keeping properties of the stalks.

Spur gear tooth crushing rolls have been installed on a 2-row corn picker to crush the borers in the stalks as the corn is picked. Preliminary tests give considerable promise.

A stationary-knife, low-cutting attachment has been worked out for the field-silage harvester. Work is under way on the construction of a standing-stalk chopper based on the silage-harvester principle.

Laboratory tests were continued on studies of the tolerance of free larvæ and borers in stalks to steam, oil flame, and electric oven. Exhaustive tests were made with a portable steaming unit, which was found to be unwieldy and impracticable as a corn-borer-control weapon.

A mobile burner of the pulled, hooded-flame type has been developed after much experimentation with various open-flame types. This hooded machine produces a high-temperature flame and is little affected by side winds. Little deterioration of the special-alloy hood plates has been noted after long periods of operation. One of these

burners was used effectively in California for combatting the pea aphid in alfalfa. Work is being done on the development of a satisfactory low-pressure fuel nozzle to replace the high-pressure nozzle now in use. An exposed-flame, regenerative type of burner unit developed for use in garden patches and fence corners has given fair results in preliminary trials. This is a 1-man outfit and is supplied with fuel oil at low pressure through a hose from a pump driven by a small engine.

Studies of plowing and corn-borer control machinery are being carried on in cooperation with the Illinois and Pennsylvania agricultural experiment stations.

A bulletin has been published on the stationary-knife, low-cutting attachment for corn binders and another on the sled-type stalk shaver. The manuscript for a bulletin dealing with the care and operation of husker-shredders in corn-borer-infested areas has been prepared.

Experimental work has been started on the Berkley, Mass., farm recently acquired by the Plant Quarantine and Control Administration and jointly operated by the Bureau of Public Roads, Plant Quarantine and Control Administration, and the Bureau of Entomology. Here opportunity is afforded to experiment with machinery under typical New England conditions.

CONTROL OF THE PINK BOLLWORM

Tests of a small hammer-mill type of feed grinder at Tallulah, La., and Tlahualilo, Mexico, in connection with studies of gin-trash disposal of pink bollworm control have shown that practically 100 per cent pink bollworm mortality can be attained by using a fairly large sized grinding screen which allows ample capacity to care for a 6-stand gin when ginning picked cotton.

The cultural control investigations in pink bollworm investigations carried out at Presidio, Tex., confirm the outstanding conclusion of the first year's work; namely, that plowing about 6 inches deep followed immediately by irrigation gives practically complete pink bollworm mortality. Many of the other 90 plowing and irrigation combinations show, to date, very promising results, although compilation of the data has not yet been completed.

ARTIFICIAL DRYING OF GRAIN

This project is a part of a general study conducted for a few years past in cooperation with the Bureau of Plant Industry and the Bureau of Agricultural Economics on the use of the combined harvester-thresher. Studies were made of a commercial grain drier located at Parshall, N. Dak., and information was obtained regarding the power, labor, and fuel requirements for drying wheat and rye and the quality and conditions of the grain before and after drying. It was found that the operating expenses of the drier were small in comparison with the increase in market value of the grain due to the reduction in moisture content, but that unless a large quantity of grain could be dried each season, interest on the investment and depreciation would make the cost excessive. A manuscript based

on the results obtained at Parshall, N. Dak., has been submitted for publication.

Similar studies have been made on commercial driers located at Beaumont, Tex., and De Witt, Ark., in connection with the artificial drying of rice. A preliminary report has been issued on rice drying.

COTTON-DRYING EQUIPMENT

Under the supervision of the division of agricultural engineering, cotton driers were installed upon a number of plantations.

Plans for all-steel cotton driers were developed, and the construction of two such driers was begun for plantations at Heathman and at Lyon, Mississippi. The construction of all-steel driers was undertaken by two of the largest manufacturers in the cotton-ginning field. Assistance was requested by these concerns, and the division, in addition to supplying technical information, also aided in the conduct of special factory tests.

COTTON INVESTIGATIONS IN THE MISSISSIPPI DELTA

At the request of prominent planters and members of the Staple Cotton Cooperative Association of Greenwood, Miss., investigations were made in connection with the ginning of over 50,000 bales of staple cotton, the grade, color, and preparation of which had been lowered as a result of undetermined causes. Cotton gins were examined; arrangements of machinery were planned; methods of handling from field to gin were investigated; and an extensive canvass of gins and plantations was made in the districts of Greenwood, Clarksdale, and Greenville, Miss. About 40 combinations of standard and home-made ginning machinery were found, each having possible bearing upon the quality of the ginned fiber.

Many of the gins were found to be deficient in cleaning and extracting equipment, but the investigations disclosed that many of those best equipped had been turning out both inferior and superior work under identical operating conditions. It was found that the inferior work was accomplished on poorly conditioned seed cotton, while superior work was done where the seed cotton had been properly conditioned. This indicates the importance of satisfactory preliminary conditioning (i. e., drying and curing) of the seed cotton before it is brought to the gins, and confirms the need of suitable driers and conditioners, especially where the early green cottons are rushed to the gins, or where the late season and unfavorable weather necessitate rough picking of the crop.

COTTON-GINNING AND FIBER INVESTIGATIONS

A series of harvesting, ginning, drying, and fiber studies was undertaken in cooperation with the Bureau of Agricultural Economics and the Mississippi Delta Experiment Station at Stoneville, Miss. Cotton of similar certified breed and growth was harvested during four distinct periods of the season. Portions of these pickings were ginned after having been conditioned in several ways. Fiber samples were obtained from the ginnings upon each lot. The results will be tabulated and analyzed.

A very important series of tests was made at the test plants of some of the principal cotton-ginning manufacturers in cooperation with the division of cotton marketing, Bureau of Agricultural Economics. At Prattville, Ala., and at Atlanta, Ga., these tests were made upon short-staple and staple cottons under variable conditions of saw speed, roll density, etc. Preliminary study of these results, together with the extensive fiber investigations previously carried out by the Bureau of Agricultural Economics, indicate the need for a ginning and fiber laboratory in which the many unknown features of quality ginning can be investigated.

FERTILIZER DISTRIBUTORS

Fertilizer distributors for cotton now on the market differ greatly in uniformity of distribution, accuracy of obtaining and maintaining desired rates of application, and the placement of fertilizer in relation to the seed. Investigations made last year indicated that the germination and yield of cotton are greatly affected by the placement of the fertilizer, particularly on sandy soils.

To obtain fundamental information which will assist in the development of more efficient fertilizer distributors, a study is in progress, in cooperation with the Bureau of Chemistry and Soils, the joint committee on fertilizer application, and Clemson Agricultural College and Experiment Station (South Carolina), of machine placement and distribution of fertilizers for cotton. A special machine has been used to apply the fertilizers accurately at desired rates in various positions in relation to the seed and with different degrees of irregularity of distribution. The fertilizers were applied and the seed planted on three types of soils in South Carolina in the spring of 1930, and the effects on germination, early bloom, and yield will be recorded at the proper intervals. Tests on machine placement of fertilizer materials applied as a side dressing to cotton at thinning time are also in progress.

FARM-LAND DEVELOPMENT

It is quite generally recognized that before much reduction can be made in the general costs of crop production modern farm machinery must be utilized to the greatest extent possible. However, not all farms are adapted to the use of such machinery. In all parts of the country there are farms on which the fields are small and irregular, containing stumps or stones, wet spots, meandering streams, gullies, or straggling bodies of timber. Under such conditions modern machinery can not be used profitably. Investigations which have for their object the determination of the net benefits to be had on typical farms through a better physical development have been initiated in North Carolina and will be extended to other States.

Investigations of development work looking to more efficient methods have been continued, mainly in cooperation with various State agencies. In such cooperative work in Minnesota, it has been found that broadcast burning can be used to great advantage in

clearing land of standing brush. Such fires can be controlled and safely used by back-furrowing and by using simple water sprinklers. A low humidity is necessary for a good fire, and burning in the fall has not been as successful as spring burning. A project to determine the costs of all the various operations in clearing land of brush and stumps on each of the four principal soil types of northern Minnesota was completed during the year. In a cooperative project in Pennsylvania the possibilities of raising buried boulders to the surface of the ground with large plows and blasting them were investigated and methods and costs determined. The experimental work in the use of poisons for killing trees and brush was continued in an effort to find a poison and method of poisoning which would be effective on all species of growth and under a wide variety of conditions.

Cooperative assistance in the agricultural-engineering features of surveys made for the purpose of classifying land according to its utility was furnished to the Bureau of Agricultural Economics and the State of West Virginia.

FARM STRUCTURES

GRAIN STORAGES

Increased facilities for the farm storage and handling of small grains in bulk have become a necessity because of the growing use of the combine harvester in many grain-producing areas, the present practice of paying premiums for wheat of high protein content, and the economic waste incident to the marketing of grain containing foreign material or dockage. Heavy losses due to the heating of grain in bins, to rodents, to excessive labor in handling, and to rapid deterioration may be attributed to improper design and construction of grain storages. Because of the lack of authoritative information regarding the best practices in grain-storage design and construction an investigation was made, and the results were published in a bulletin prepared in cooperation with the Bureau of Agricultural Economics. A subsequent study of the storage of corn and small grains was begun.

GREENHOUSE HEATING

The study of greenhouse heating was brought to a close, and the results are being prepared for publication. The data presented should be of material assistance to small owners of commercial greenhouses and to such local heating contractors as are unfamiliar with greenhouse heating problems.

STRUCTURES RESEARCH SURVEY

The many problems related to the design and construction of farm buildings of all kinds offer a rich field for research. Since farm buildings for the most part must be fabricated on the farm without the assistance of engineer or architect, it is evident that research in

this field must be conducted by public agencies. The facilities for making such investigations have been and are very limited, being entirely lacking in some of the State institutions. In view of the urgent need of research in farm structures, a survey was undertaken with the purpose of ascertaining what research activities are in progress throughout the country, what facilities are available, and what problems are awaiting solution as the basis for a national program of coordinated effort in structures research so administered as to stimulate activity, bring into action all available agencies and resources, and correlate and disseminate results. The field work of the survey has been practically completed during the year. There remains the preparation of a report and the formulation of a program of further procedure.

SEPTIC TANKS

The purpose and functioning of a septic tank are quite generally misunderstood. Because of this misunderstanding and the poor results so often obtained, a survey was made of a large number of installations in order to obtain first-hand information regarding the design and operation of various types of tanks and the causes of failures. The data obtained are yet to be analyzed, but it is quite evident that much of the dissatisfaction reported is due to neglect of the system and that regular, periodic removal of the sewage solids is essential to satisfactory performance. Recommendations based on the results of the survey should be of value to many rural-home owners.

SERVICE WORK

The service rendered other bureaus of the department greatly exceeded in volume that of the preceding years. The following partial list of such projects shows the wide scope of the activities which the bureau is called on to undertake.

Plans and specifications were prepared for a new shop and office building, a combined bulb storage and nursery laboratory, and three head houses for the Arlington Experiment Farm. Plans and specifications were also prepared for a zoological laboratory for the Beltsville Experiment Farm.

The necessary calculations were made and specifications prepared for about 15 refrigerating plants. Most of these plants were intended for use in investigational work and hence called for special design.

Calculations were made to determine the capacity of seven boiler plants, and in some instances specifications were prepared for the boilers.

Calculations and the layout of wiring were made for two high-tension electrical distribution systems. Specifications were drawn for electric motors, meters, heaters, isolated generating sets, etc., and calculations were made for electric heaters, incubators, and water-distilling apparatus for laboratories.

Four temperature-control systems were designed for as many different bureaus.

Specifications have been prepared for concrete mixers, gas engines, machine tools, and other miscellaneous equipment.

A dam designed by this bureau for the Bureau of Biological Survey was completed at the Wind Cave Game Preserve in South Dakota. A migratory-bird refuge, on the design of which the division furnished assistance is now under construction by the same bureau at the mouth of Bear River, Utah, and preliminary investigations have been made for a similar refuge in Oregon.

Plans and specifications were prepared for a small reservoir to be built in Wyoming for the Bureau of Plant Industry.

Some service work has also been performed for the State, Interior, Treasury, and Post Office Departments.



REPORT OF THE SOLICITOR

UNITED STATES DEPARTMENT OF AGRICULTURE,
OFFICE OF THE SOLICITOR,
Washington, D. C., August 30, 1930.

SIR: I submit herewith report of the work of the Office of the Solicitor for the fiscal year ended June 30, 1930.

Respectfully,

ELTON L. MARSHALL, *Solicitor.*

HON. ARTHUR M. HYDE,
Secretary of Agriculture.

The Office of the Solicitor of the Department of Agriculture had its beginning in 1905, when Congress made an appropriation for one solicitor. On June 17 of that year Secretary James Wilson defined the duties of the solicitor in General Order 85, as follows:

He will act as the legal adviser of the Secretary, and is charged with preparation and supervision of all legal papers to which the department is a party, and of all communications to the Department of Justice, and to the various officers thereof, including United States attorneys. He will examine and approve, in advance of issue, all orders and regulations promulgated by the Secretary under statutory authority. He will represent the department in all legal proceedings arising under the various laws intrusted to the department for execution. He will prosecute applications of employees of the department for patents, under the terms of Department Circular No. 3, 1905. His duties will be performed under the immediate supervision of the Secretary.

In the act of May 26, 1910, making appropriations for the Department of Agriculture for the fiscal year 1911 (36 Stat. 424), Congress declared that "hereafter the legal work of the department shall be performed under the supervision and direction of the solicitor." Subsequently, general orders were promulgated by the Secretary placing on the solicitor the responsibility for all the legal work of the department.

In 1905, when the Office of the Solicitor was established, the regulatory acts committed to the department for administration and enforcement were comparatively few. At that time the principal acts were the organic act of the Bureau of Animal Industry of 1884, dealing with the prevention and extirpation of certain animal diseases; the act of August 30, 1890, providing for export meat inspection; the cattle inspection act of 1891, requiring safe transportation and humane treatment of export cattle; the cattle quarantine act of February 2, 1903; the animal quarantine act of March 3, 1905; the 28-hour livestock transportation act of 1873; the forest service administrative act of June 4, 1879, which had been transferred to the Department of Agriculture from the Department of the Interior on

February 1, 1905; and the Lacey Act of May 25, 1900, regulating the importation of, and interstate commerce in, wild birds and animals.

In 1906 two acts of special significance to the people of this country were passed. These were the food and drugs act and the meat inspection act. A more comprehensive 28-hour law was also passed, limiting the time during which animals may be confined in railroad cars without rest, food, and water. Since that date there has been scarcely a session of Congress in which one or more regulatory acts have not been enacted and committed to the department for enforcement. So rapid and extensive was the growth of the legal work of the Office of the Solicitor and the consequent increase in its professional and clerical force that, in 1910, it was found expedient to organize several divisions, with a chief attorney in charge of each. The legal work was distributed among these divisions, in order that the head of each division and his assistants might become specialists in their work as a result of devoting themselves exclusively to the consideration of legal questions arising out of the administration or enforcement of a group of similar or related statutes. Time has proven the wisdom of this plan, and the large volume of legal work expeditiously performed annually by each division shows that the system thus established is functioning satisfactorily.

At the last session of Congress an act of vital importance to shippers of perishable agricultural commodities was enacted and committed to the department for administration and enforcement. Under this act a farmer who ships such commodities in interstate commerce has the assurance that, when the party with whom he is dealing is a commission merchant or broker, he will receive a prompt and correct account of the transaction. The migratory bird conservation act of February 18, 1929 (45 Stat. 1122), became effective July 1, 1929, but an appropriation for beginning the department's purchase program was not available until July 1, 1930. By this act the Secretary is authorized to acquire lands in various parts of the United States for migratory-bird refuges. Pursuant to the act, a large amount of work involving the examination of titles has been undertaken by this office, and such work will continue for a considerable time. This statute will greatly enlarge the title work now performed by the office under the Weeks law and the upper Mississippi River wild life conservation act.

Another act of outstanding significance passed by the last Congress is one amending the food and drugs act. Under it, authority is conferred upon the Secretary to establish standards of quality, condition, and/or fill of containers for certain classes of **canned goods**. This amendment covers a wide range of articles and will add materially to the work of the office.

Up to the present time some 50 regulatory acts have been committed to the department for administration and enforcement. The questions arising under these acts cover practically every branch of the law, and many complex legal questions arise, and much litigation necessarily occurs in connection with their enforcement. Litigation of this kind has grown to such great proportions that much of the time of some of the lawyers in the office is taken up in assisting the United States attorneys, in response to their requests, in the preparation, prosecution, and argument of the more important cases in

which the department is interested. Owing to the manifold duties devolving upon the United States attorneys in handling matters for all the departments of the Government, they lack the time to devote to the preparation of these cases which the technical issues of law and fact would exact of them, and as a result they seek the aid of the attorneys in this office. This cooperation with the United States attorneys in such matters has been not only cordial but also very advantageous to the department's interests.

The office has been uniformly successful in handling the department's litigation during the year. In *Bianchi & Co. v. The Secretary of Agriculture and the Chief of the Bureau of Public Roads*, the plaintiff brought an injunction proceeding in the Supreme Court of the District of Columbia to test the authority of the Secretary of Agriculture, under the Federal highway act, to withhold approval of contracts for Federal-aided road projects inaugurated by the States, to which plaintiff would be a party, until the plaintiff had made an adjustment with the State of Maine under a previous contract for road building. The Secretary had found that the work had not been performed by plaintiff in accordance with the specifications, although plaintiff's performance of said work had been approved by the Secretary's predecessor in office. The issue raised in this case was the legal right of the Secretary to reopen the question as to the plaintiff's past performance in respect to the Maine contract in view of his predecessor's determination that such contract had been fulfilled. A further question was presented as to whether the Secretary of Agriculture was invested with authority to pass upon the qualifications of a contractor for Federal-aided road projects. Upon argument the court dismissed the bill and rendered an opinion upholding the right of the Secretary, at his discretion, to disapprove road contracts where a contractor's past performances were found by the Secretary to be unsatisfactory, and to require such contractor as a condition for the approval of his contracts to adjust claims for past unsatisfactory work on Federal-aided road projects. It was further held that the Secretary was not bound, under the circumstances disclosed in the bill of complaint, by the decision of his predecessor in office as to the fulfillment of the Maine contract; the conclusion of the court being that the Secretary had full discretionary powers under the Federal highway act to approve or disapprove contracts thereunder, the exercise of which could not be controlled by injunction. Plaintiff has, however, appealed the case to the Court of Appeals of the District of Columbia, where it is now pending.

Another injunction proceeding was brought in the Supreme Court of the District of Columbia by the National Remedy Co., a Massachusetts corporation, to restrain the Secretary of Agriculture, the director of regulatory work, and the chief of the division of drug control from instituting multiple-seizure suits under section 10 of the food and drugs act against the plaintiff's medicinal preparation, known as the B. & M. external remedy, as an adulterated and misbranded product under the food and drugs act. The National Remedy Co. claimed that the defendants' action in the institution of multiple seizures and threatening further seizures of plaintiff's product was oppressive and beyond the bounds of their lawful authority under the law, and the company also contended that the

seizures brought and contemplated were illegal because the plaintiff was not afforded a preliminary hearing before the institution of seizure proceedings. The plaintiff further contended that a finding of the judgment of the District Court of New Hampshire in a previous proceeding against plaintiff's product, which terminated in a verdict and judgment for plaintiff, precluded the institution of any further adverse action against its product under the food and drugs act. The issues thus raised were duly argued upon hearing of the case and the court, in its ruling, decided all of them adversely to plaintiff. This case is likewise now pending on appeal before the Court of Appeals of the District of Columbia.

An injunction suit in the Supreme Court of the District of Columbia, brought in a previous fiscal year to restrain the Secretary of Agriculture and the Secretary of the Treasury from permitting the importation of crude ergot under section 11 of the food and drugs act, was heard on appeal in the Court of Appeals of the District of Columbia and decided adversely to the plaintiffs. It was alleged that the ergot was substandard and unfit for use in the preparation of the medicinal extract known as fluid extract of ergot, and it was contended that the Secretary's duty under the section cited was mandatory and permitted the exercise of no official discretion in the determination of the admissibility of drugs. The appellate court sustained the decision of the lower court, denying both the temporary and permanent injunction asked for upon the ground that the Secretary's duty was discretionary and that his finding as to the admissibility of the drug, unless arbitrary or capricious, was not subject to review by the courts.

Another illustration of office work calling for legal ability of a high order is to be seen in the enforcement of the packers and stockyards act of 1921. Under this law numerous hearings are held, most of which are attended by two attorneys from this office, one as examiner and the other as attorney for the Government. These hearings may be divided into two main groups: One involving trade practices alleged to be in violation of the act; and the other dealing with the reasonableness of the rates and charges (1) of the commission men for buying and selling livestock, and (2) of the stockyards for yardage, feed, and the like. Trade-practice hearings are keenly contested because the respondents feel that their reputation for business honesty and fair dealing is involved and employ able counsel to defend themselves. In the rate cases the valuation of property aggregating several million dollars in a single case may be involved. Expert witnesses appear for both sides. These hearings frequently extend over a long period of time and result in a large mass of testimony. This testimony is digested, briefs are prepared, and arguments made before the Secretary by both sides. It is readily apparent that much time and effort is necessarily employed in the preparation and efficient handling of these cases involving, for the most part, intricate questions of law and fact.

The work of the office has been conducted economically and expeditiously during the fiscal year, and there follows a statistical summary of that part of the work.

Four hundred and seventeen written opinions were rendered to administrative officials of the department. No record was kept of

the advice given these officials in daily, informal consultations, nor of opinions briefly expressed in writing on papers sent to this office for consideration.

Eight hundred and fifty-two notices of judgment were prepared for publication, pursuant to authority contained in the food and drugs, insecticide, and naval stores acts.

In addition to the criminal prosecutions hereinafter tabulated, 968 decrees of condemnation and forfeiture were entered under the food and drugs act, 14 under the insecticide act, and 4 under the Federal seed act.

There were reported to the Attorney General 2,038 violations of statutes intrusted to the department for enforcement.

Table 1 shows the several statutes under which these violations were reported and the amounts of fines and recoveries in cases settled with and without contest:

TABLE 1.—*Cases reported, fines imposed, and judgments recovered, fiscal year 1930*

Laws involved	Number of cases	Fines and recoveries	Laws involved	Number of cases	Fines and recoveries
National forest laws.....	163	\$56,323.94	Naval stores act.....	2	\$50.00
Food and drugs act.....	63	10,676.00	Produce agency act.....	2	600.00
Migratory bird treaty act.....	305	9,641.04	Federal seed act.....	1	200.00
28-hour law.....	290	29,075.00	Upper Mississippi wild life and fish refuge act.....	4	100.00
Meat inspection act.....	20	5,150.00	Miscellaneous.....	29	229.26
Plant quarantine act.....	34	3,165.00			
Animal quarantine acts.....	47	4,025.00			
Insecticide act.....	9	462.00			
Section 84, penal code.....	3	10.00	Total.....	972	119,707.24

TABLE 2.—*Contracts and leases prepared or examined, fiscal year 1930*

Bureau, division, or office	Contracts	Leases	Total	Bureau, division, or office	Contracts	Leases	Total
Forest Service.....	1,797	1	1,798	Extension Service.....		1	1
Biological Survey.....		5	5	Food and Drug Administration.....	5	7	12
Bureau of Agricultural Economics.....	8	38	46	Grain Futures Administration.....		3	3
Bureau of Animal Industry.....	10	65	75	Personnel and Business administration.....	8		8
Bureau of Chemistry and Soils.....	2	5	7	Plant Quarantine and Control Administration.....	10	40	50
Bureau of Dairy Industry.....	5	5	10	Weather Bureau.....	10	30	40
Bureau of Entomology.....	10	39	49				
Bureau of Home Economics.....	1	1	2	Total.....	1,907	311	2,218
Bureau of Plant Industry.....	27	51	78				
Bureau of Public Roads.....	1	12	13				
Chief clerk.....	13	8	21				

During the year 15 bonds, 429 renewals, and 28 terminations of leases and contracts were prepared. In addition to the examination of the tabulated contracts and the bonds connected therewith for sufficiency as to execution (Table 2), there were also examined 110 bonds of indemnity covering advances under the subsistence expense act of 1926 and the act of June 3, 1902, and 997 Federal highway project contracts, 615 modifications of such contracts, 60 contracts for the construction of roads within or partly within national forests, and 35 original and modified agreements for flood-relief road work

in the several States authorized to receive such relief under the acts of May 16, 1928, and February 29, 1929.

Five hundred and sixty certifications of papers, records, and bulletins of the department were prepared at the request of litigants for use as evidence by them in court proceedings.

Twenty claims of balances due estates of deceased employees were examined, necessary papers were prepared for their payment, and advice was given to administrative officials on matters relating thereto.

Mortgages and liens were prepared and advice given administrative officers in connection with loans made by the department to farmers under joint resolution of Congress of March 3, 1930. An attorney of this office was detailed for several months to Columbia, S. C., to handle the legal work in connection with these loans.

Twelve employees of the department were arrested while in the performance of their official duties for alleged violations of the traffic regulations and were represented at the hearings and trials by attorneys in this office.

Forty-four claims involving damages to privately owned property resulting from the alleged negligence of employees of the department, while engaged in the performance of their official duties, were considered under the act of December 28, 1922, and advice given with respect thereto.

Twenty-nine miscellaneous cases covering claims for damages arising out of automobile accidents and actions for the recovery of money due the United States were referred to the Department of Justice. In several instances payments of claims were secured from individuals and corporations without litigation, as a result of correspondence conducted with them by this office.

Attorneys in the office attended or participated in a number of hearings held under the packers and stockyards act of 1921, as well as hearings pertaining to other activities of the department. Many conferences were attended on matters relating to the administration of the plant quarantine, grain standards, United States warehouse, standard container, and national forest laws. Frequent conferences were held with attorneys and others interested in seizure and criminal cases pending in the Federal courts under the food and drugs, and insecticide and fungicide acts, and numerous conferences were also had with attorneys and others on legal matters touching the various other regulatory laws administered by the department.

Regulations issued by the Secretary under the various statutes committed to the department for administration were prepared, or assistance was given in their preparation. Among the more important of these were regulations governing the recognition of breeds and purebred animals, the inspection of live poultry, the inspection, humane treatment, and safe transport of animals for exportation from the United States, and regulations promulgated under the standard container, farm products inspection, and plant quarantine laws. Assistance was also given to the preparation of many amendments to regulations issued under various other regulatory laws. Many proclamations, forms, specifications, and schedules required in the enforcement of the regulatory laws were also prepared. Orders governing the interstate movement of plants and livestock, grain

inspection, cotton standards, and the fiscal administration of the department were also prepared, revised, or reviewed. Statements of issues, briefs, and memoranda on other legal matters were prepared at the request of the officials of the department for submission to the Attorney General, the Secretary of the Interior, and the Comptroller General. Numerous service and regulatory announcements, circulars, and bulletins referred to this office for consideration from a legal aspect were reviewed and comments made thereon.

Many bills for various purposes referred to the department for comment by committees of Congress were examined, and assistance was rendered in the preparation of reports thereon. Among the bills considered were S. 1133, a bill designed to amend the food and drugs act by authorizing the Secretary of Agriculture to establish reasonable standards for canned goods, except canned meat and canned milk, and requiring canned foods falling below such standards to bear on the label a plain and conspicuous statement that they fall below the standard; H. R. 9896, to regulate the purchase of personal property for the use of the Federal Government; S. 2117 to authorize arrests in certain cases, and to protect employees of the Department of Agriculture in the execution of their duties; S. 3470 to establish definitions and standards for preserves, jams, jellies, and apple butter, and to require imitations of those products to be labeled as such; S. 3557, providing for the acquisition of certain timberlands and the sale thereof to the State of Oregon for recreational and scenic purposes; S. 3594, authorizing appropriations for the construction and maintenance of improvements necessary for the protection of the national forests from fire and for other purposes; S. 4129, to regulate the purchase and sale of cotton or grain for future delivery; and S. 4172, to aid in the maintenance of engineering experimental stations in connection with the colleges established in the several States under the provisions of an act approved July 2, 1862, and of the acts supplemental thereto.

A bill to amend the packers and stockyards act of 1921 in certain particulars was prepared for the Bureau of Animal Industry, and assistance was given in the preparation of a bill to authorize the Secretary of Agriculture to establish uniform standards for the market classification and grading of livestock products, and to maintain standard grading service therefor, and for other purposes. Assistance was given in the preparation of a bill to authorize the Secretary of Agriculture to cause to be made an inspection of poultry and the products thereof for the purpose of preventing their transportation in commerce when unsound, unhealthful, unwholesome, or otherwise unfit for human food.

Briefs and memoranda on legal questions involved in many of the cases reported to the Attorney General for prosecution were prepared and furnished, and assistance was also given the United States attorneys in trials of some of the cases. Among the more important of these were *United States v. B. & M. External Remedy*, *United States v. Shreveport Grain & Elevator Co.*, *United States v. Capon Springs Water*, *United States v. Evaporated Apples*, *United States v. Tilden & Co.*, *United States v. Chichester Pills*, *United States v. Bred Spred*,

and United States *v.* Lee's Save the Baby, all involving violations of the food and drugs act; United States *v.* A. A. & L. E. Meyer, a violation arising under the naval stores act; United States *v.* Lee's Lice Killer, involving a violation of the insecticide and fungicide act; also United States *v.* Kraus et al., United States *v.* Smith, United States *v.* Brown, and United States *v.* Silberman Sons Co., all involving suits by the Government for the recovery of excess wool profits.

Complaints in 28-hour violations and, when practicable, libels in food and drugs cases, were prepared and furnished the United States attorneys, and indictments and informations in practically all the criminal cases reported for prosecution under the regulatory laws of the department were also prepared and submitted to various United States attorneys. In some instances, where direct action has been taken by the United States attorneys in plant-quarantine violations on facts presented by local inspectors, the indictments and information have been prepared by this office at the request of United States attorneys.

THE NATIONAL FORESTS

During the fiscal year there were handled 240 claims for lands within the national forests which were initiated under the public land laws of the United States. Decisions were rendered on 118 of these claims, of which 97 were favorable to the Government and 21 were unfavorable. Attorneys of this office participated in the trials of 29 court cases and represented the Government before the United States local land offices in 23 hearings. There were handled also 253 trespass cases, involving property of the United States on national forests. Oral advice was frequently given, and numerous written opinions relating to the administration of the national forests were submitted. There were prepared or passed upon for legal sufficiency 2,300 legal papers of various kinds.

Work for the Forest Service during the fiscal year, other than under the Weeks forestry law, included handling the following cases and other business:

Claims to lands pending during year.....	240
Hearings attended.....	23
Briefs prepared and filed.....	46
General litigation and settlement.....	27
Contracts, leases, bonds, etc.....	1, 379
Bills, complaints, informations, protests, etc.....	373
Abstracts of title examined.....	71
Court appearances.....	29
Written opinions.....	403
Stipulations.....	27
Trespasses:	
Grazing.....	56
Timber.....	24
Fire ¹	146
Property.....	8
Occupancy.....	19

¹ All cases prosecuted in State courts not included.

TABLE 3.—*Trespass cases on the national forests in which damages and fines were recovered, fiscal year 1930*

Character of trespass	Number	Damages	Fines
Grazing.....	36	\$4, 866. 28	\$25. 00
Timber.....	18	9, 468. 53	-----
Fire ¹	102	19, 955. 38	1, 367. 75
Property.....	4	-----	66. 00
Occupancy.....	3	20, 075. 00	500. 00
Total.....	163	54, 365. 19	1, 958. 75

¹ All cases prosecuted in State courts not included.

CASES OF INTEREST

A fraudulent mining claim in the Tonto National Forest was disposed of on November 4, 1929, when Judge Sawtelle, United States district judge for Arizona, issued a permanent injunction against Charles Stewart restraining him from occupying land in that forest on a pretended mining location. Stewart had been given a special-use permit for 1½ acres of land in December, 1925, authorizing him to maintain a tourist-supply station. His occupancy proved undesirable in that the buildings and sanitary conditions were not up to the standard requirements for the national forest. The permit was accordingly revoked. He then made a mining location which he called the "Dinty Moore." The mineral values existed only in his imagination, but, nevertheless, he resisted any attempt to remove him from the premises and refused to discontinue his business. Judge Sawtelle held that since the land was under a withdrawal for construction of reclamation works it was not subject to mineral location. He therefore issued the injunction.

In a proceeding against Langmade & Mistler, a mill-site location in the Crook National Forest, which was laid out so as to include the greatest possible frontage along a public highway and land especially desirable for recreational and camping purposes, was declared invalid by the Secretary of the Interior on the ground that under the circumstances the applicants had not established their good faith in claiming the land for mining uses.

In *Beard v. United States* the Circuit Court of Appeals for the Ninth Circuit sustained the district court in enjoining Beard from interfering with the administration and protection of the Angeles National Forest, Calif., and from maintaining possession, improvements, or any structures on land at the junction of the west fork of the San Gabriel River and Short Cut Canyon occupied by the Forest Service as the West Fork ranger station. The court also ordered Beard and his agents to vacate the premises. Beard, relying upon a private survey, claimed that the ranger station occupied a portion of a certain section 16 granted to the State of California for school purposes, and which he had purchased from the State's grantee. The court rejected the private survey and accepted the official Government survey which established that the land was not a part of the school section. Beard had previously been successful in a suit against the forest supervisor in a State court. He had also protested the official survey made by the Land Office following the action in the

State court but was unsuccessful. The district law officer at San Francisco prepared the pleadings and briefs in the case in cooperation with office of the United States attorney.

In a proceeding before the Secretary of the Interior involving land within the Beaverhead National Forest, Mont., an unsuccessful attempt was made by John A. Grosso to obtain, under the placer mining laws, patent for land chiefly valuable on account of the tailings deposited thereon during previous mining operations by another party. In accordance with the usual practice, the land was examined by a mining engineer of the Forest Service, who found that it had no value of its own for mining purposes. The tailings constituted its only mineral value. These tailings, estimated to be worth more than \$1,000,000, had been saved by the mining operator for possible future value and had been confined by cribbing of logs and bags. The Secretary of the Interior held that since the mineral applicant failed to show that the land itself had any mineral value, he was not entitled to patent. Title to the land thus remains in the United States, and the tailings remain the personal property of their lawful owner. Motion for rehearing was denied July 29, 1930. A brief was filed and argument made before the Secretary of the Interior by an attorney of this office.

WEEKS FORESTRY LAW (36 Stat. 961)

The National Forest Reservation Commission at two meetings held during the year authorized the purchase by the Secretary of Agriculture of 667 separate tracts of land, aggregating a total area of 502,538 acres. The total acreage to which titles were examined was approximately 500,000, and the consummated acquisitions by purchase, condemnation, and exchange, amounted to 416,068 acres. Approximately 72,438.94 acres, comprising 140 authorizations, are now in condemnation, 78,129 acres are in process of exchange, and 124,672 acres are in process of purchase or in preparation for institution of condemnation proceedings. (Table 4.)

There were prepared during the year 411 agreements covering purchases of land under this law.

TABLE 4.—*Operations under the Weeks forestry law, fiscal year 1930*

State	Purchases authorized	Acreage acquired	Acreage in condemna- tion
	<i>Acres</i>	<i>Acres</i>	<i>Acres</i>
Alabama.....	6,425	7,929	2,094.77
Arkansas.....	37,118	99,914	5,021.88
Florida.....	83,796	85,015	-----
Georgia.....	55,082	10,047	9,785.35
Louisiana.....	49,860	9,613	11,187.35
Maine.....	-----	121	-----
Michigan.....	45,693	71,627	-----
Minnesota.....	29,072	35,440	-----
New Hampshire.....	4,734	280	22,036.72
North Carolina.....	13,398	7,607	2,815.64
Pennsylvania.....	9,500	25,996	16,276.50
South Carolina.....	2,762	1,113	483.55
Tennessee.....	8,729	3,359	1,045.04
Virginia.....	7,450	6,996	1,692.14
West Virginia.....	17,795	35,505	-----
Wisconsin.....	131,124	15,606	-----
Total.....	502,538	416,068	72,438.94

UPPER MISSISSIPPI RIVER WILD LIFE AND FISH REFUGE ACT (43 Stat. 650)

Nine cases involving violations of the upper Mississippi River wild life and fish refuge act were reported to the Attorney General for prosecution, and four cases were terminated by assessment of fines of \$25 in each case.

Titles to 20,522.6 acres of land, involving 221 tracts, were examined and their acquisition was accomplished by the Government during the year. This was an increase of 33½ per cent over the acquired acreage of the preceding year, and a 40 per cent increase of titles actually examined. There were 106 abstracts of titles, covering 10,880.91 acres of land, prepared and submitted to the Attorney General for his approval.

During the year 26 tracts, comprising 1,164.89 acres were condemned and titles thereto vested in the United States by final decree entered in the condemnation suits. Petitions for the institution of proceedings for the condemnation of 52 parcels of land, involving 1,590.14 acres, were prepared and submitted to the Attorney General.

FOOD AND DRUGS ACT (34 Stat. 768)

At the beginning of the fiscal year there were pending in the courts 376 cases under the Federal food and drugs act, of which 70 were criminal and 306 were civil. During the year there were reported to the Department of Justice 52 criminal and 1,041 civil cases, a total of 1,093 cases reported. There were thus pending during the year 122 criminal and 1,347 civil cases, making a total of 1,469 cases in all. There were terminated during the year 77 criminal and 1,039 civil cases, or a total of 1,116 cases in all, leaving 45 criminal and 308 civil cases, or a total of 353 cases in all, pending at the close of the fiscal year.

In 63 of the 77 criminal cases terminated, fines were imposed; 55 after pleas of guilty and 8 on pleas of nolo contendere. Thirteen cases were nol-prossed or dismissed, and the statute of limitations barred the filing of the information in one case. (Table 5.)

TABLE 5.—*Fines imposed in criminal cases (exclusive of costs which were generally assessed) under the foods and drugs act, fiscal year 1930*

Num- ber of cases	Amount of fine	Total	Num- ber of cases	Amount of fine	Total
	<i>Dollars</i>	<i>Dollars</i>		<i>Dollars</i>	<i>Dollars</i>
1	4	4	1	175	175
2	5	10	6	200	1,200
1	20	20	4	250	1,000
13	25	325	1	300	300
1	30	30	1	400	400
6	50	300	1	500	500
1	72	72	2	550	1,100
1	75	75	1	600	600
1	80	80	1	800	800
12	100	1,200	1	1,750	1,750
1	135	135			
4	150	600	63	-----	10,676

Of the 1,039 civil cases terminated, 546 were terminated by default decrees, 422 by consent decrees, and 1 case was terminated by trial, resulting in a verdict for the Government, although, at the end of the year, no decree had been entered. Seventy cases were dismissed, chiefly because no seizure of the goods had been effected. In three of these, however, trial was had before the court without a jury, and verdicts were rendered against the Government and the libels ordered dismissed.

Eight hundred and twenty-five notices of judgments were prepared and published during the year.

CASES OF INTEREST

The case of *United States v. Shreveport Grain and Elevator Co.*, instituted in the western district of Louisiana, was based on criminal information containing two counts, each count charging that the defendant had previously shipped in interstate commerce a number of sacks of an article of food which were short weight and therefore misbranded in violation of the act. The defendant moved to quash the information, contending that the language of section 8, paragraph 3, the so-called net weight amendment of the food and drugs act, on which the information was predicated, was too indefinite and uncertain to afford a valid definition of a crime, as required by amendment 6 of the Constitution, and, further, that this lack of definiteness and certainty incidentally violated amendment 5 of the Constitution in that it deprived the defendant of liberty and property without due process of law. The defendant also demurred to the information on the broad ground that it charged no offense against the laws of the United States. In deciding the issues thus raised, the district court sustained the contention of the defendant that paragraph 3 of section 8 of the food and drugs act was unconstitutional as being too uncertain in its terms. An application for rehearing, however, was immediately filed and granted, and at the close of the fiscal year the court still had the case under consideration.

The appeal in the case of *United States v. Bred Spred*, in the Circuit Court of Appeals for the Fifth Circuit, was from a judgment entered in favor of the claimant in the United States District Court for the southern district of Indiana. Seizure actions had been instituted in the eastern district of Michigan and the southern district of Indiana against two consignments of a product called "Bred Spred." At the trial of the Michigan case the court dismissed the libel, holding that the theory of the Government's case was based on an erroneous construction of the statute. The claimant's answer in the Indiana case, in addition to containing specific denials of the averments of adulteration and misbranding of the article, set up the record and judgment in the Michigan case as a bar to the seizure proceeding against the product in Indiana. A motion filed by the Government to strike out all matters relative to the Michigan case was denied. In order further to urge the irrelevancy and immateriality of the Michigan judgment, and also to raise other questions as to the sufficiency in law of the defense of former adjudication, the Government interposed a demurrer to the answer, which was overruled. The Government, having elected to

stand on its demurrer, final judgment was entered in favor of the claimant, and an appeal was taken. Upon hearing, the Circuit Court of Appeals for the Fifth Circuit, in affirming the judgment, decided that, even if it held with the contention of the Government on the question of former adjudication and estoppel, it could not for that reason reverse the judgment because by its demurrer the Government admitted that a good defense existed on the merits of the case.

In a seizure proceeding against another shipment of the same product in the southern district of Iowa, the amended answer of the claimant denied the adulteration and misbranding charges alleged in the libel and set up as a bar a judgment rendered in its favor in a similar case in the eastern district of Michigan. The Government moved to strike from the amended answer all matters pertaining to the Michigan case, and after hearing and argument, the court sustained the motion. At the trial on the merits the Government abandoned all allegations of adulteration and misbranding, except that the article had been mixed in a manner whereby its inferiority was concealed and that it was an imitation of jam. After proving the ingredients of the article, the Government offered further evidence that the pectin in the preparation jelled the mixture so as to make it appear to contain more fruit than it actually did and offered evidence of manufacturers, housewives, and wholesale grocers that jam consists of at least 45 parts fruit and 55 parts sugar. The Government then rested, and the claimant, without introducing any testimony, rested and moved for a directed verdict. After argument the court directed the jury to return a verdict for the claimant and dismissed the libel. The Government reserved its exception to this ruling, and the same is now pending on appeal.

THE INSECTICIDE ACT OF 1910 (36 Stat. 331)

Twenty-five cases were reported to the Attorney General during the fiscal year ended June 30, 1930, in 5 of which, involving 10 violations, criminal proceedings were recommended. Twenty seizure (civil) cases were reported during the year. At the close of the fiscal year ended June 30, 1929, 32 cases were pending, of which 27 were criminal prosecutions and 5 were seizure cases.

Fourteen cases pending at the close of the fiscal year ended June 30, 1929, and 15 cases reported during the fiscal year ended June 30, 1930, 29 cases in all, were terminated during the year. Of the cases so terminated, 13 were criminal and 16 were seizure cases. Fines were imposed in 9 of the criminal cases, and 4 were dropped or dismissed.

Fourteen of the seizure cases were closed upon default decrees of condemnation, forfeiture, and destruction of the goods, one decree in favor of the goods was entered, and one case was closed for the reason that no goods were found of which to make seizure. (Table 6.)

TABLE 6.—*Fines in criminal cases in which convictions were obtained under the insecticide act of 1910, fiscal year 1930*

Num- ber of cases	Amount of fine	Total	Num- ber of cases	Amount of fine	Total
	<i>Dollars</i>	<i>Dollars</i>		<i>Dollars</i>	<i>Dollars</i>
1	2	2	1	75	75
1	5	5	3	100	300
2	25	50			
1	30	30	9	-----	462

Twenty-five notices of judgment were prepared and published under section 4 of the act.

A CASE OF INTEREST

The sole question presented by the assignments of error to the Circuit Court of Appeals for the Ninth Circuit in the case of *United States v. Lee's Lice Killer* was whether, in a proceeding under the insecticide act against a misbranded shipment of manufactured insecticide of definite composition and labeling, a judgment adverse to the Government estops the Government from proceeding against another shipment of the same product with similar misbranding. The Circuit Court of Appeals held that the prior judgment in the western district of Missouri in favor of the George H. Lee Co., the claimant, barred the Government from proceeding against other shipments of the product with similar labeling.

Steps have been taken to recommend to the Department of Justice that a petition for certiorari be filed seeking a review by the United States Supreme Court of the decision of the Circuit Court of Appeals.

MEAT INSPECTION ACT (34 Stat. 1260)

Twenty-nine cases representing 32 violations were reported to the Attorney General for prosecution under the meat inspection act. Of these, and the 60 cases pending in the district courts at the beginning of the year, 37 were terminated by the assessment of fines and disposed of as follows: 1 of \$500, 1 of \$300, 2 of \$200 each, 1 of \$150, 7 of \$100 each, 2 of \$50 each, 1 of \$25, 2 of \$10 each, 1 of \$5, and 15 in which convictions were had, suspended fines or jail sentences were given and the defendants were placed upon probation, while in 4 the defendants were given jail sentences. Eleven other cases were dropped or dismissed, and in 4 cases the grand juries failed to indict. Verdicts of not guilty were returned in 2 cases.

In reporting to the Attorney General one of the cases referred to above, the department suggested the advisability of instituting proceedings against the individual members of the company. Two additional indictments were accordingly secured, each against five members of the company, resulting in their conviction. In one of these cases, fines aggregating \$1,550 were assessed, and in the other the fines aggregated \$1,400. (Table 7.)

On July 1, 1930, 23 cases which had been reported prior to July 1, 1929, and 12 cases reported during the fiscal year 1929-30, were still pending, making a total of 35 cases pending on July 1, 1930.

TABLE 7.—*Fines imposed in meat inspection cases, fiscal year 1930*

Num- ber of cases	Fine	Total	Num- ber of cases	Fine	Total
	<i>Dollars</i>	<i>Dollars</i>		<i>Dollars</i>	<i>Dollars</i>
1	1,550	1,550	2	50	100
1	1,400	1,400	1	25	25
1	500	500	2	10	20
1	300	300	1	5	5
2	200	400			
1	150	150	20	-----	5,150
7	100	700			

VIRUS-SERUM-TOXIN ACT (37 Stat. 833)

Advice was given the administrative officers on various legal problems arising in connection with the enforcement of this statute.

NAVAL STORES ACT (42 Stat. 1430)

One criminal case was pending at the beginning of the year. Two cases were prepared and referred to the Attorney General during the fiscal year for prosecution, and of these two cases one is pending in court and in the other the defendant entered a plea of nolo contendere and was fined \$50.

Two notices of judgments were prepared and published during the year.

Opinions, both formal and informal, upon various legal matters arising in the administration of this statute were rendered to the officials charged with its enforcement.

FEDERAL SEED ACT (37 Stat. 506)

At the beginning of the fiscal year there were four criminal cases pending under the Federal seed act. During the year there were reported to the Department of Justice 6 cases, all civil cases, which were terminated during the year, 3 by the entry of consent decrees, 1 on a default decree, and 2 were dismissed because no seizure had been effected. Two criminal cases were terminated; in one, on a plea of nolo contendere, a fine of \$200 was imposed, and the other was placed in permanent abeyance because the evidence was deemed insufficient to warrant the return of an indictment. There were thus pending at the end of the year two criminal cases. These had been presented to the grand jury in and for the eastern district of South Carolina, the jurisdiction from which the shipments involved were made, and no true bills were returned. In the belief that with a change of venue the Government would be successful in having indictments returned against the defendants therein, the cases were thereafter referred to the United States attorneys for the eastern district of Louisiana and the southern district of Mississippi, the jurisdictions into which the shipments were made, for presentation to their respective grand juries.

In addition to handling the foregoing cases a number of informal opinions were furnished the administrative officers in charge of the enforcement of this act.

FEDERAL CAUSTIC POISON ACT (44 Stat. 1406)

Informal opinions were furnished on application to a number of members of the trade as to their liability under the Federal caustic poison act, and opinions, both formal and informal, upon questions arising in the course of the administration of the statute were rendered to the administrative officers charged with its enforcement.

FEDERAL IMPORT MILK ACT (44 Stat. 1101)

Advice was given to the administrative officers on various legal problems arising in connection with the enforcement of this statute.

PLANT QUARANTINE ACT (37 Stat. 315)

Prosecutions were instituted under the plant quarantine act in 50 cases during the year, of which 45 were reported to the Attorney General or to United States attorneys direct, and the remaining 5 were instituted by United States attorneys on information furnished by inspectors of the department. Of these, 29 were closed by the imposition of fines, 2 by suspended sentence without imposition of fines, and 4 by dismissal. At the close of the fiscal year 1929 there were 6 cases pending, 5 of which were closed during this year by the imposition of fines. (Table 8.)

TABLE 8.—*Fines imposed in plant quarantine cases, fiscal year 1930*

Num- ber of cases	Amount of fine	Total	Num- ber of cases	Amount of fine	Total
	<i>Dollars</i>	<i>Dollars</i>		<i>Dollars</i>	<i>Dollars</i>
3	5	15	8	100	800
3	10	30	1	200	200
8	25	200	1	1,400	1,400
2	35	70			
6	50	300	34	-----	3,165
2	75	150			

There were 16 cases pending at the close of the year, of which 1 was pending at the beginning of the year and 15 were submitted during the year.

Fourteen written opinions were given on legal questions raised by the Plant Quarantine and Control Administration and many verbal opinions were given in conference with members of the administration.

Conferences were also had with the Plant Quarantine and Control Administration and the Bureau of Plant Industry in the preparation of one new domestic quarantine, No. 68, involving the Mediterranean fruit fly in Florida; of many amendments to the regulations supplemental to domestic quarantines; and of amendments to regulations supplemental to foreign quarantines or orders.

FEDERAL HIGHWAY ACT (42 Stat. 212)

Project statements for 486 Federal-aid road projects approved by the department during the fiscal year were first reviewed to determine whether they were eligible under the law. The amount of

Federal aid which will be allocated for these projects has not yet been determined, as under the project-statement form now used a project covers the whole route involved between given control points and the Federal aid is requested and allocated only as each section of the project is reached for actual construction.

During the fiscal year 997 project agreements and certificates of approval of plans, specifications, and estimates, prepared by the Bureau of Public Roads, were reviewed as to their form and sufficiency of execution by the State highway departments, and were submitted to the Secretary and executed by him. Drafts of 615 modifications of project agreements and certificates of approval, prepared by the Bureau of Public Roads for execution by the State highway departments and the Secretary, were similarly reviewed. These project agreements, together with the increases provided by the modifications of agreements, involved a total estimated cost of \$182,632,591.73 and Federal aid in the amount of \$76,809,709.80. They involved also the original improvement with Federal aid of 5,553.5 miles of road and additional improvements of 2,597.6 miles of road. In addition to the foregoing, project substitutions to the number of 83 were reviewed during the fiscal year and were approved by the Secretary.

There were also reviewed as to form, substance, and sufficiency of execution 60 original contracts for the construction of roads within or partly within the national forests. There were similarly reviewed 42 cooperative agreements between the department and cooperating agencies for constructing roads within or partly within national forests.

Project statements for 25 flood-relief projects and 14 original and 10 modified agreements for flood-relief projects were reviewed as to form, substance, and sufficiency of execution on the part of the States and recommended for approval by the Secretary of Agriculture. These flood-relief projects involved 41.6 miles of road and \$741,486.41 as the Federal share of the cost of their construction.

Six written opinions were given to the Bureau of Public Roads and three to the Forest Service on legal questions arising with reference to the administration of the Federal highway act by these two bureaus.

ACTS RELATING TO THE INTERSTATE MOVEMENT OF LIVESTOCK FROM QUARANTINED DISTRICTS PROHIBITING THE INTERSTATE MOVEMENT OF DISEASED LIVESTOCK AND PROHIBITING THE IMPORTATION OF DISEASED LIVESTOCK (23 Stat. 31, 26 Stat. 414, 32 Stat. 791, 33 Stat. 1264)

Eighteen cases involving violations of the act of May 29, 1884 (23 Stat. 31), were reported to the Attorney General for prosecution, of which 3 were terminated by fines of \$100 each, 7 by dismissal, and 1 by the entry of an order of nolle-pros. Of the cases pending at the close of the preceding fiscal year, 3 were terminated by fines of \$100 each and 7 by the entry of orders of nolle-pros, the costs of prosecution, however, being imposed on the defendant in each case. Ten cases were pending at the close of the fiscal year.

Sixty-three cases were reported to the Attorney General for prosecution under the act of February 2, 1903 (32 Stat. 791), of which 9 were terminated by fines of \$25 each, 17 by fines of \$100 each, 2 by dismissal, and 1 by the refusal of the grand jury to return a true bill. Of the cases pending at the close of the preceding fiscal year, 9 were terminated by fines of \$100 each, 3 by dismissal, 4 by the entry of orders of nolle-pros, and 3 by the action of the court in sustaining demurrers to the informations filed, based on the invalidity of the regulation on which the latter were predicated. Forty-eight cases were pending at the close of the fiscal year.

Seven cases under the act of March 3, 1905 (33 Stat. 1264), were reported to the Attorney General for prosecution, of which 1 was terminated by a fine of \$100, 1 by a verdict of not guilty, and 1 by a plea of guilty but with sentence suspended for five years. Of the cases pending at the close of the preceding fiscal year, 5 were terminated by fines of \$100 each, 3 by dismissal, and 1 by a verdict of not guilty. There were six cases pending at the close of the year. (Table 9.)

TABLE 9.—*Cases under animal quarantine laws disposed of by the imposition of fines, fiscal year 1930*

Number of cases	Amount of fine	Total
	<i>Dollars</i>	<i>Dollars</i>
38	100	3 800
9	25	225
47	-----	4,025

In all, 88 cases under the animal quarantine laws were reported to the Attorney General during the year, and 64 were pending at the close thereof.

Eleven bonds to insure the handling, in accordance with the regulations of this department, of hides and skins imported from foreign countries were examined during the fiscal year.

In five instances, where suit had been brought in State courts against employees of the Bureau of Animal Industry in connection with the performance of their inspection duties, memoranda have been prepared for the Department of Justice setting forth the facts, and in each instance a United States attorney has been directed to appear, and has appeared, in behalf of such employee at court.

DECISIONS OF INTEREST

Mann Carter and Will Carter were convicted in the United States District Court for the Southern District of Georgia of using and of conspiring to use deadly weapons to prevent certain employees of the Bureau of Animal Industry of this department from carrying on their official work of supervising and assisting in the dipping of cattle in violation of section 62 of the penal code (35 Stat. 1100). The defendants appealed to the Circuit Court of Appeals for the Fifth Circuit on the principal ground that the cattle which the

Federal employees required to be dipped were not the subject of interstate commerce but were domestic cattle over which the Bureau of Animal Industry had no jurisdiction or control. Recognizing that the cattle were not themselves the subject of interstate commerce, the appellate court said, nevertheless, that they were liable to infect cattle which were the subject of such commerce. Specifically, it held that, in the protection of interstate commerce in cattle, the Federal Government has power to require that domestic cattle be treated in an effort to eradicate Texas fever, and affirmed the judgment of the lower court. On June 9, 1930, without written comment, the Supreme Court of the United States denied appellants' application for a writ of certiorari to review the question.

A case instituted in the United States District Court for the Southern District of Ohio against Wert A. Whipp, et al., differing from the foregoing only in that the disease the department's employees were investigating was bovine tuberculosis, likewise resulted in the conviction of the offenders. The defendants filed notice of their intention to appeal from the conviction but at the close of the fiscal year had not perfected such action.

TWENTY-EIGHT HOUR LAW (34 Stat. 607)

Four hundred and one cases were reported to the Attorney General under the 28-hour law.

Penalties aggregating \$29,075 were recovered in 290 cases, and 18 cases were dismissed. (Table 10.)

TABLE 10.—*Penalties assessed under the 28-hour law, fiscal year 1930*

Number of cases	Penalty	Total
	<i>Dollars</i>	<i>Dollars</i>
1	25	25
287	100	28,700
1	150	150
1	200	200
290	-----	29,075

Two hundred and seventy-seven cases were pending at the close of the year.

Regulations governing the recognition of breeds and purebred animals (B. A. I. Order 319) and governing the inspection of live poultry and the inspection, humane treatment, and safe transport of animals for exportation from the United States (B. A. I. Order 322), issued by the Bureau of Animal Industry, revising previous regulations on the same subjects, were examined and approved as to their legal sufficiency, as were also other orders issued by that bureau.

MIGRATORY BIRD TREATY ACT (40 Stat. 755)

Three hundred and three cases were reported to the Attorney General under the migratory bird treaty act. (Table 11.)

TABLE 11.—*Fines imposed under the migratory-bird treaty act*

Number of cases	Amount of fine	Total	Number of cases	Amount of fine	Total
	<i>Dollars</i>	<i>Dollars</i>		<i>Dollars</i>	<i>Dollars</i>
4	0.01	0.04	1	35.00	35.00
6	1.00	6.00	35	50.00	1,750.00
77	5.00	385.00	1	75.00	75.00
77	10.00	770.00	13	100.00	1,300.00
31	15.00	465.00	1	250.00	250.00
5	20.00	100.00	1	500.00	500.00
51	25.00	1,275.00	1	2,700.00	2,700.00
1	30.00	30.00			
-----	-----	-----	305	-----	9,641.04

In 16 cases, defendants were sentenced to jail or to the custody of United States marshals for terms ranging from 1 hour to 6 months.

Defendants were acquitted in 4 cases, and 97 cases were either abandoned, dismissed, or nolle-prossed. In one case, the grand jury refused to indict.

BIRD AND ANIMAL RESERVATION TRESPASS LAW (See 84, Penal Code)

Twelve new cases were reported to the Attorney General under section 84 of the penal code. Of the cases so reported, and of those pending at the close of the previous year, three were closed, two by a fine of \$5 each, and the defendants in the other case were sentenced to serve 90 days in jail.

BEAR RIVER MIGRATORY BIRD REFUGE ACT (45 Stat. 448)

Two titles covering approximately 15,860.65 acres of land were examined in connection with the establishment of refuges authorized by this act. These purchases amounted to \$24,547.28.

MIGRATORY BIRD CONSERVATION ACT (45 Stat. 1222)

Titles to two tracts of land comprising 37,735.7 acres of land were examined during the year. These acquisitions were acquired under this act, and their cost amounted to \$42,547.30. Advice was given to the administrative offices on legal questions arising in connection with the administration of the act.

NATIONAL ARBORETUM

Five petitions for use in the condemnation of approximately 90 acres of land in the District of Columbia were prepared and submitted to the Attorney General. Advice in regard to acquisitions for the establishment of this arboretum was given the administrative officers.

MOUNT VERNON MEMORIAL HIGHWAY (45 Stat. 721)

The Government has acquired by purchase and donation for the purposes of the Mount Vernon Memorial Highway 32 tracts of land, comprising approximately 127 acres located in Arlington and Fairfax Counties, Va. Examinations of 70 titles in connection with

such acquisitions were completed, 14 of which were commenced during the year, and 56 of which were begun in the previous fiscal year. Thirteen condemnation suits were instituted to accomplish acquisitions under this law. One of these has been concluded, and a decree has been entered therein vesting title to the land involved in the proceeding in the United States.

Considerable time and attention have been devoted to the completion of transfers of property for the purposes of the memorial highway, involving the negotiation of contracts with the owners, the preparation of deeds and other instruments of conveyance, and transacting other business necessarily arising through the conduct of this kind of work.

PACKERS AND STOCKYARDS ACT (42 Stat. 159)

During the fiscal year 24 notices of inquiry were prepared involving practically every kind of a case which may arise under the packers and stockyards act such as, among others, inquiries into the reasonableness of stockyard rates and of the rates charged by market agencies; insolvency; trade practices; and failure to give bond as required by the act.

Oral arguments were made in several cases before the Secretary. Conferences were held with attorneys and others interested, directly or indirectly, in matters arising in connection with the administration of the act. Many legal questions under this law were considered, and opinions both formal and informal were rendered thereon to the department officials.

Twenty-six Secretary's orders were prepared, such as cease and desist orders, orders of suspension of registration, orders prescribing the records to be kept by registrants, orders prescribing rates for stockyard services, and orders of dismissal.

HEARINGS

During the fiscal year hearings were held as to the reasonableness of the rates and charges made by the St. Joseph Union Stockyards Co. at St. Joseph, Mo.; the Denver Union Stockyards Co., Denver, Colo.; and the market agencies doing business at the Sioux City Stockyards, Sioux City, Iowa. A hearing was begun, but not finished, during the fiscal year involving the rates and charges of the Kansas City Stockyards, Kansas City. Also a number of hearings involving trade practice and insolvency cases were held.

COURT CASES

On February 24, 1930, the United States Supreme Court handed down a decision in *Tagg Bros. & Moorehead et al. v. United States* (280 U. S. 420), which upheld the right of the Secretary of Agriculture to prescribe rates for buying and selling livestock at public stockyards. In this case, commonly called the Omaha rate case, the validity of an order issued by the Secretary of Agriculture fixing the commission rates at Omaha was challenged.

In the case of *United States v. Roberts & Oake*, packers, arguments were presented before the Federal District Court at Chicago, Ill., on June 16. This arose out of an order by the Secretary re-

quiring the respondent to furnish suitable bond as required by the statute.

The Nashville Union Stockyards filed a petition seeking to enjoin the Secretary from enforcing the rates and charges prescribed by him after full hearing for stockyards services rendered at said stockyards. The stockyard company subsequently withdrew its petition and paid the costs.

A number of opinions in regard to the packers and stockyards act were rendered during the fiscal year.

UNITED STATES GRAIN FUTURES ACT (39 Stat. 483)

Proceedings under the act were pending at the end of the fiscal year against three members of the Board of Trade of the City of Chicago before a referee designated by the Secretary of Agriculture as chairman of a commission created by the act. This commission consists of the Attorney General, the Secretary of Commerce, and the Secretary of Agriculture. The complaint charges manipulation of prices and failure to keep records of all transactions as required by the act. In such cases the act authorizes an order by the commission requiring all contract markets to refuse the guilty persons all trading privileges on the market for a period designated in the order.

A CASE OF INTEREST

Suit for an injunction was filed July 28 by Attorney General Sorensen, of Nebraska, against the Omaha Grain Exchange seeking to enjoin it from collecting charges for unloading, weighing, transferring, reloading, and inspecting grain sold subject to its rules for shipment outside of Omaha. If the exchange continues to enforce its rules on these charges, the State asks that its franchise be dissolved. The attorney general alleges that the charges "will continue to depress the prices of all grains moving through Omaha." The purpose of the suit is to test the constitutionality of the Nebraska statute making it unlawful to exact these charges. The grain exchange has answered that experience demonstrates that the weighing rules have built up the market rather than harmed it. The case is pending, and its outcome will determine the fairness and reasonableness of the exchange rules and their effect upon the price paid to the shippers and producers in its territory.

UNITED STATES WAREHOUSE ACT (39 Stat. 486)

Opinions were rendered on a number of questions arising in the administration of the act, and regulations for carrying out its provision were reviewed as to their legal sufficiency. In a case involving forgery of the receipts of a licensed warehouse the defendant, on a plea of guilty, was sentenced to 28 days that he had already served in jail, and further sentence was suspended on five years' probation.

PRODUCE AGENCY ACT (44 Stat. 1355)

A number of cases were brought to trial under this act and disposed of during the year. Penalties were imposed therein, varying from \$500 on two counts in one case, to \$100 and 30 days in jail in another.

In one case, in which a fine of \$100 was imposed, the United States attorney reports that the court was advised that the defendant had made full payment with interest to the shipper, and undoubtedly took this fact into consideration. Assistance was given to the administrative officers on matters arising in connection with the enforcement of the act.

UNITED STATES GRAIN STANDARDS ACT (39 Stat. 478)

Considerable time and study were given to conferences and opinions in connection with questions growing out of the possible establishment of a service for the determination of the protein content of wheat. The special grain survey committee conferred frequently with this office on questions arising in its work and requested several opinions. In addition to this there was the usual work incident to the enforcement of the act, including the consideration of disciplinary action against licensed inspectors and the publication of findings as to violation of the act by members of the trade.

UNITED STATES COTTON FUTURES ACT (42 Stat. 1517)

Advice and assistance was given administrative officers on questions arising in the administration of the act and on amendments to the regulations.

FEDERAL WATER POWER ACT (41 Stat. 1063)

Opinions were rendered to the Forest Service on questions involving the interpretation and application of the Federal water power act in the administration of the national forests.

UNITED STATES COTTON STANDARDS ACT (42 Stat. 1517)

Several opinions were rendered upon questions submitted by the trade and the administrative officials. The usual assistance was given the administrative officers in the enforcement of the act.

STANDARD CONTAINER ACTS OF 1916 AND 1928 (39 Stat. 625 and 45 Stat. 685)

Opinions were rendered to the administrative officers respecting the effect of these two acts in relation to State legislation on the same subject. Several conferences were held with State officials with reference to the validity of municipal ordinances. Preparation was made for court proceedings on several prospective violations of the 1928 act, but no action became necessary. Confiscation proceedings were instituted in one case at Denver, Colo.

CENTER MARKET ACT (41 Stat. 1441)

Advice and assistance were given the administrative officers on questions arising in the administration of this act.

COLLECTION AND DISTRIBUTION OF EXCESS PROFITS ON WOOL
CLIP OF 1918

When the present fiscal year began, the case of *United States v. Kraus & Apfelbaum* (which had been pending in the Circuit Court of Appeals for the Seventh Circuit on an appeal from the decision of the District Court for the Southern District of Indiana sustaining a demurrer to the complaint), had just been decided in favor of the United States. The court held that, by agreeing to operate their business subject to the regulations, the wool dealers became bound by contract to surrender to the United States the excess profits they made in handling wool of the regulated clip. The court was of opinion that, by virtue of the agreement, the wool dealers acted as agents for the United States in handling the wool. This case was briefed and argued in the Circuit Court of Appeals by an attorney of this office.

During the preceding year the cases of *United States v. R. E. Smith* and *United States v. Brown & Adams*, commonly referred to as "the Boston cases," had been tried in the District Court for the District of Massachusetts and there decided in favor of the respective defendants, and authority to appeal to the Circuit Court of Appeals for the First Circuit had been requested of the Attorney General. During the present year the requested authority was granted and the appeals were taken. The bill of exceptions in *United States v. Brown & Adams* was prepared by an attorney of this office, who also briefed and argued both cases in the circuit court of appeals. That court decided both cases adversely to the United States, holding that the agreements entered into by the respective defendants to operate their business subject to the regulations were made under duress and did not constitute valid contracts, and that defendants had not by receipt of benefits under the regulations become estopped to deny the validity thereof. The Attorney General was requested to apply to the Supreme Court for writs of certiorari to review these decisions of the circuit court of appeals, but declined to do so.

In *United States v. S. Silverman Sons Co.*, demurrer to the declaration in which had been sustained in the preceding fiscal year, an amended declaration was drafted by an attorney of this office and filed. Demurrer to this amended declaration came up for argument on June 18, 1930, and, as the court was not able to hear oral argument, the case was submitted on briefs.

Except for the taking of depositions in preparation for the trial of the *Kraus & Apfelbaum* case and a continuance of the special efforts made since the initiation of this work to persuade the courts to hear, try, and decide pending cases, there was no other trial work in the collection of excess wool profits suits other than that outlined.

PATENTS

During the year 59 applications for letters patent on inventions of employees of the department were prepared and filed, and 111 such applications were awaiting adjudication in the Patent Office at the close of the year. Twelve applications were allowed. Ten applications are pending in interference proceedings declared by

the Patent Office between applications for letters patent of employees of this department and applications filed by outside parties. Briefs were prepared and filed and oral arguments made before examiners and boards of the Patent Office in some of the cases.

Numerous questions were submitted to the office bearing on the patentability, validity, and infringement of patents. Much time and effort were expended in answering these inquiries, as in many instances their correct solution necessitated extended research in the various patent arts.

Table 12 shows the status of applications on June 30, 1930.

TABLE 12.—*Patents applied for by members of the department, fiscal year 1930*

Applicant	Bureau	Invention	Disposition of application
Max Phillips	Chemistry and Soils	Lignin	Pending.
Do	do	Lignin and furfural	Allowed.
Edwin C. E. Lord	Public Roads	Process for hardening cement	Pending.
Harry D. Tiemann	Forest Service	Drying lumber	Do.
A. T. Goldbeck	Public Roads	Roughness determinator	Do.
Louie C. Fleck	Forest Service	Acetylated wood product	Do.
Wm. B. Cruess	Agricultural College, University of California.	Preparing fruit candies	Do.
Do			
J. H. Irish	Chemistry and Soils	Dried fruit juices	Do.
P. H. Richert			
P. H. Groggins	do	Metal polish	Allowed.
W. Schooler	do	Para-phenyr (14 applications)	Pending.
P. H. Groggins	do	Obtaining oil from peel of citrus fruits.	Do.
W. E. Sutton	do	Preventing fruit decay (six applications).	Do.
W. R. Barger	Plant Industry	Spraying composition	Do.
P. A. van der Meulen	Entomology	Spray material	Do.
E. R. van Leuwen	do	Poisoned bait and spray material	Do.
P. A. van der Meulen	do		
Do			
E. R. van Leuwen	do		
Oscar Anderson			
H. R. Fulton	Plant Industry	{ Prevention of decay in fruits (six applications). }	Do.
J. J. Bowman			
R. C. Roark	Chemistry and Soils and Entomology.	Ethylene dichloride	Do.
R. T. Cotton	Chemistry and Soils	Insecticide	Do.
R. C. Roark	do	Rotenone	Do.
Do			
Do	Chemistry and Soils and Entomology.	{ Moth-proofing composition }	Do.
E. A. Beck			
R. T. Cotton			
R. C. Roark	do	Moth-proofing articles	Do.
E. A. Beck			
R. T. Cotton	do	Fungicide	Do.
R. C. Roark			
R. T. Cotton	Experiment Station, La.	Process for manufacturing alcohol.	Allowed.
W. L. Owen	do	Fermentation processes	Do.
Do			
L. A. Rogers	Dairy Industry	Preparation of milk.	Pending.
Do	do	Preservation of cheese (three applications).	Do.
C. E. Hrubesky	Forest Service	Glue	Do.
F. L. Browne			
E. H. Siegler	Entomology	Tree bands (two applications)	Do.
S. Palkin	Food and Drug Administration.	Purification of ether	Do.
Do	do	{ Purification and preservation of ether. }	Do.
H. R. Watkins			
L. A. Pinck	Chemistry and Soils	Nitrating cellulose substances	Do.
H. Hetherington	do	Producing urea	Do.
H. J. Krase	do	Process for oxidation of ammonia.	Do.
J. Y. Yee	do	Apparatus for oxidation of ammonia.	Do.
Do			
W. L. Beare	Public Roads	Resilient connections	Do.
Marion Dorset	Animal Industry	Vaccine	Do.

TABLE 12.—*Patents applied for by members of the department, fiscal year 1930—*
Continued

Applicant	Bureau	Invention	Disposition of application
E. A. Richman	Entomology	Beetle traps	Allowed.
J. M. Schaffer	Animal Industry	Disinfectant and antiseptic	Do.
Do.	do.	Disinfectant and germicidal	Do.
R. W. Bell	Dairy Industry	Amorphous lactose	Pending.
Do.	do.	Milk sugar	Do.
E. H. Wiegand	University of Oregon	Fruit grading machine	Allowed.
J. F. Barghausen	Agricultural Economics	Meat grader	Pending.
Do.	do.	Cheese-grading machine	Do.
G. P. Walton	Entomology	Fertilizer	Do.
R. F. Gardiner	Plant Industry	Weed killer	Do.
H. R. Offord	do.	Treatment of textiles	Do.
G. Van Atta	do.	Portable spray	Do.
H. R. Offord	Agricultural Economics	Spout sampler	Allowed.
N. Mirov	Animal Industry	Parasiticides	Pending.
J. F. Breaker	Public Roads	Stalk-cutting apparatus	Do.
W. C. Wheeler	Entomology	Eradication of insects	Do.
J. M. Schaffer	Chemistry and Soils	Insecticide (six applications)	Do.
F. W. Tilley	Experiment Station, Fla.	Irrigation system	Do.
S. W. McBirney	Chemistry and Soils	Egg preservation	Do.
W. W. Yothers	Plant Quarantine and Control Administration	Destruction of insect larvæ	Do.
H. C. Tilden	Weather Bureau	Recording wind vane	Do.
R. H. Carter	Plant Industry	Sulphur dioxide vaporizing	Do.
E. F. DeBusk	Experiment Stations	Pectin	Do.
T. L. Swenson	University of Maryland	Chocolate milk	Do.
E. M. Dittenbach	Plant Industry	Reinforcing material	Do.
B. C. Kadel	do.	Tree dressings	Do.
A. J. Winkler	do.	Prevention of fruit decay	Do.
H. E. Jacob	Public Roads	Cotton ginning	Do.
P. B. Myers	do.	Cotton dryer	Do.
L. Zern	Biological Survey	Mouth speculum	Do.
R. C. Munkwitz	Home Economics	Material measurer	Do.
R. C. Steadman	University of Oregon	Removal of spray and wax residue from fruits	Do.
J. S. Cooley	Plant Quarantine and Control Administration	Insect detector	Do.
C. A. Bennett	Chemistry and Soils	Fungicide	Do.
Do.	do.	Preservation of eggs	Do.
K. B. Hanson	Forest Service	Fuming wood	Do.
J. S. Mihlek	do.	Calculating device	Do.
T. Dantzig	do.	Moisture indicator	Do.
E. Peterson	Chemistry and Soils	Tanning process	Allowed.
R. H. Robinson	Agricultural Economics	Color measurer	Pending.
Do.	University of Oregon	Vaccine	Do.
R. E. McDonald	Plant Industry	Preservation of peanut butter	Allowed.
G. J. Scholl	Entomology	Insecticide	Pending.
B. F. Dana	Chemistry and Soils	Manufacture of glucose and corn sugar	Do.
G. W. Musgrove	do.	Decolorizer	In interference.
T. L. Swenson	Plant Industry	Fungicide	Do.
R. Thalen	Food and Drug Administration	Spray remover	Do.
I. G. Haig	do.	do.	Do.
G. Kempff	Chemistry and Soils	Dye	Do.
C. J. Suits	Plant Industry	Fungicide	Do.
M. E. Dunlap	Chemistry and Soils	Ethylene oxide	Do.
R. W. Frey	Forest Service	Pulp	Do.
Dorothy Nickerson	Animal Industry	Germicide	Do.
W. T. Johnson	do.	do.	Do.
J. H. Battie	Plant Industry	Fungicide	Do.
A. Jackson	Chemistry and Soils	Ethylene oxide	Do.
O. I. Snapp	Forest Service	Pulp	Do.
H. S. Paine	Animal Industry	Germicide	Do.
M. S. Badollet	do.	do.	Do.
J. W. Turrentine	do.	do.	Do.
H. R. Fulton	do.	do.	Do.
J. J. Bowman	do.	do.	Do.
A. M. Henry	do.	do.	Do.
Do.	do.	do.	Do.
Courtney Conover and H. B. Gibbs	Chemistry and Soils	Dye	Do.
J. W. Roberts	Plant Industry	Fungicide	Do.
R. O. Roark	Chemistry and Soils	Ethylene oxide	Do.
R. T. Cotton	Forest Service	Pulp	Do.
J. D. Rue	Animal Industry	Germicide	Do.
S. D. Wells	do.	do.	Do.
F. G. Rawling	do.	do.	Do.
J. M. Schaffer	do.	do.	Do.
Do.	do.	do.	Do.

CASE OF INTEREST

The case of the Selden Co. against the National Aniline & Chemical Co. (Inc.), tried in the United States District Court for the Western District of New York, involved an action in equity for infringement by the defendant company of patents Nos. 1285117 and 15520 (reissue) granted to two employees of the United States Department of Agriculture. These patents covered a process for making phthalic anhydride, phthalic acid, benzoic acid, and naphthaquinones useful in a variety of industries, and apparatus for carrying out the process and controlling the generating heat and bringing about reactions of gases. These patents were granted without the payment of fees by the inventors, under the act of March 3, 1883, which authorized the issuance of patents in such cases, if the inventors in their applications stated that the Government and the people of the United States may use the inventions without the payment of royalty, and this dedication had been made by the inventors. The department, upon request, granted the inventors permission to apply for foreign patents for the subject matter of the process patented. After filing their applications for patents the inventors assigned all their rights in and to the inventions to the plaintiff company which claimed infringement on the part of the defendant. The defendant maintained that, under the circumstances and since the discoveries were made in the course of research work at Government expense, the resultant inventions were in fact dedicated to the free use of any person in the United States. Plaintiff urged that there was no dedication to the public of a patent issued under the act referred to above in that the Government only acquired right of use in such an invention. These contending positions were due to conflicting opinions previously rendered by officials of the United States, the later opinion sustaining the position taken by the plaintiff. Prior to this opinion it seems that all those concerned assumed that since the discoveries were made in the course of research work by the inventors at Government expense, free use would be extended to any person in the United States. The court upheld this view, refusing to follow the later administrative opinion, and held that the inventors and their assignee were precluded from claiming any interest in the patents at variance with the free use by the public of the inventions involved and that no assignable rights were retained by the inventors aside from those to foreign patents rights that eventuated solely because of the permission granted by the Secretary of Agriculture.

The work of the office, considering its nature, was current at the end of the year.

UNITED STATES DEPARTMENT OF AGRICULTURE
WEATHER BUREAU
Washington, D.C.
September 15, 1930.

Sir: I submit herewith a report of the work of the Weather Bureau during the fiscal year ended June 30, 1930.

Respectfully,

C. H. Marvin

Chief of Bureau.

Hon. Arthur M. Hyde,
Secretary of Agriculture.

*For more complete report
W37A*

RELEASE DEC 8

The topics chosen for particular discussion in this report are the drought of 1930 and expansions of service in aid of aviation.

THE UNPRECEDENTED DROUGHT OF THE SUMMER OF 1930

Basing the statement on weather reports up to August 31 we may say that the drought and heat wave are over, but reports for the remainder of the year will be required before a full history can be written.

The central and eastern portions of the country have now passed through the most severe drought in the climatological history of the United States. By the first of September the drought had continued for nine months in the middle Atlantic area, six months over the Ohio and middle Mississippi Valleys, and for shorter periods in nearly all other sections east of the Rocky Mountains. The middle Atlantic area was dry during the winter season. In March the drought extended westward over the Ohio and middle Mississippi Valleys, and thence in other directions as the season progressed.

For the spring months, March to May, West Virginia, Kentucky, Indiana, Illinois, and Missouri had the least precipitation of record, with the average for the group only 57 per cent of normal, while the middle Atlantic area had only slightly more than 60 per cent. In June, the Ohio and lower Mississippi Valleys suffered most, while by July deficiencies in precipitation extended to all States east of the Rocky Mountains, except New England and Georgia. In this month 18 States had only 20 to 50 per cent of normal rainfall, with an average of 39 per cent. In August the drought continued in nearly all sections and was greatly intensified in some Northern and Southeastern States not theretofore seriously effected.

For the summer, June to August, a belt of States extending from Maryland and Virginia southwestward to the lower Mississippi Valley established new rainfall records for the season, while in a group of 16 States, including Pennsylvania, Maryland, Virginia, West Virginia, Tennessee, Kentucky, Ohio, Michigan, Indiana, Illinois, Missouri, Oklahoma, Arkansas, Texas, Louisiana, and Mississippi, the average precipitation was only 54 per cent of normal. Not a single State east of the Rocky Mountains had as much as normal precipitation for this period of the three principal growing months, and some half dozen States had less than half the normal. The summer season was generally warm, with the period from about the middle of July to middle of August having abnormally high temperatures, with the previous maximum records equalled or exceeded in many places. These unusually high temperatures greatly intensified the effect of the deficient moisture.

July and August combined brought the driest weather of record to Pennsylvania, Maryland, Virginia, West Virginia, Kentucky, Missouri, and Arkansas, with an average for these seven States of only 41 per cent of normal. The growing season, as a whole, March to August, was the driest of record over a large area, comprising the Middle Atlantic States and the Ohio and middle Mississippi Valleys.

Table 1 contains a summary of drought data by months. The deficiencies in rainfall, the percentages of normal, are shown for each State, for all successive months when the amounts were continuously below normal, the heavy type indicating the greatest deficiencies of record for the respective months. This tabulation shows graphically the spread of the drought as the season progressed. For example, in January, only three States that continued dry thereafter had deficient precipitation, while for March the number had increased to 9; May to 10; June to 19; and July to 30. It will be noted that South Dakota and Nebraska had more than normal rainfall in August, hence there were only two consecutive months with deficiencies.

Considering the New England States as a unit, and also Maryland and Delaware, there are 32 units and units and States east of the Rocky Mountains. Of these, 27 had deficient rainfall in March, with an average deficiency of 40 per cent; 27 in April, with an average deficiency of 38 per cent; 20 in May, with an average deficiency of 29 per cent; 24 in June, with an average deficiency of 34 per cent; 30 in July, with an average deficiency of 52 per cent; and 30 in August, with an average deficiency of 45 per cent.

Table 1. Deficiencies in precipitation, in percentages of normal, for the drought of 1930, by States and months, for the period continuously below normal.

	Dec.	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Number of Months	Average monthly defi- ciency
Maryland and Delaware	<u>27</u>	18	30	42	26	38	15	<u>64</u>	<u>76</u>	9	37
Virginia	34	18	52	44	33	36	26	<u>62</u>	<u>65</u>	9	41
West Virginia	26	49	17	16	45	46	<u>36</u>	<u>59</u>	45	9	38
Missouri			19	53	47	28	22	<u>76</u>	44	7	41
Kentucky				53	68	30	<u>55</u>	<u>70</u>	39	6	52
Ohio				18	34	53	42	<u>62</u>	28	6	40
Indiana				54	26	55	32	47	36	6	42
Illinois				53	21	55	13	<u>70</u>	41	6	42
North Dakota				<u>89</u>	14	19	11	58	33	6	37
Alabama					65	5	53	26	22	5	34
Montana						41	43	35	7	4	32
Arkansas							<u>79</u>	<u>80</u>	32	3	64
Tennessee							<u>68</u>	46	38	3	51
Mississippi							<u>87</u>	50	27	3	55
Louisiana							<u>88</u>	39	14	3	47
Texas							<u>36</u>	58	43	3	46
Oklahoma							3	68	40	3	37
Kansas							5	<u>41</u>	10	3	19
Minnesota							5	29	67	3	34
Iowa								61	29	2	45
Wisconsin								<u>30</u>	<u>67</u>	2	48
Michigan								54	<u>73</u>	2	64
Pennsylvania								50	66	2	58
New Jersey								13	29	2	21
New York								23	36	2	30
North Carolina								38	49	2	44
South Carolina								18	61	2	40
Florida								<u>40</u>	39	2	40
Georgia									63	1	--
Nebraska *							16	56	47	2	--
South Dakota *							26	63	31	2	--

*August above normal.

UNDERScore INDICATES GREATEST DEFICIENCY OF RECORD

The drought has established the following low precipitation records for the periods named:

Maryland and Delaware: December to August; March to August summer (June to August); July; August; July and August combined.

Virginia: December to August; March to August; summer (June to August); July; August; July and August combined.

West Virginia: December to August; March to August; spring (March to May); summer (June to August); June; July; July and August combined.

Kentucky: March to August; spring (March to May); summer (June to August); June; July; July and August combined.

Ohio: March to August; July.

Indiana: March to August; spring (March to May).

Illinois: March to August; spring (March to May); July.

ouri: March to August; spring (March to May); July.
ly and August combined.

as: Summer (June to August); June; July; July and August combined.

Tennessee: Summer (June to August); June.

Mississippi: Summer (June to August); June.

Louisiana: June.

Minnesota: August

Pennsylvania: March to August; July and August combined.

OTHER NOTED DROUGHTS.

Previous outstanding droughts in the United States are of record for the years 1881, 1894, 1901, 1911, 1916, and 1924.

Table 2 contains data comparing these with the drought of 1930. It shows the percentage of normal precipitation for each of the droughts for the spring months March to May combined and for June, July, and August separately. A comparison of the figures shows that the 1930 drought, when considered in all its details, easily takes first place in the climatological drought history of the country.

--Percentage March to May, Ju
and August 4, 1901, 1911,

1894			1911	
March to May June July			March to May June Ju	
			64	105
72	46	89	80	83
84	73	48	80	98
77	68	49	95	102
82	65	41	81	97
90	68	41	87	100
84	59	45	82	72
88	80	62	73	37
133	33	105	90	58
81	55	93	96	86
76	51	93	92	91
84	55	116	94	102
100	88	98	95	96
107	79	81	102	27
101	42	55	59	29
69	120	48	61	15
54	84	41	75	47
74	60	16	83	40
102	83	33	63	51
125	97	23	92	89
--	--	--	104	112
148	64	20	93	93
133	83	25	92	88
133	90	46	92	100
130	64	53	77	115
113	63	37	80	146
105	93	67	72	110

Table 2. --Percentage of normal percipitation for March to May, June, July,
and August in 27 States, 1930, 1881, 1894, 1901, 1911, 1916, and 1924

State	1930				1881				1894				1901				1911				1916				1924			
	March to May	June	July	August	March to May	June	July	August	March to May	June	July	August	March to May	June	July	August	March to May	June	July	August	March to May	June	July	August	March to May	June	July	August
Maryland	64	85	36	24	79	182	54	26	---	---	---	---	128	79	123	135	64	105	61	230	98	151	125	51	153	136	57	95
Virginia	61	74	38	35	68	74	74	27	72	46	89	76	138	108	104	198	80	83	68	136	79	135	121	73	137	107	77	98
W. Virginia	64	64	41	55	89	131	90	30	84	73	48	52	144	126	70	127	80	98	61	167	102	120	76	120	140	104	98	115
Kentucky	51	45	30	61	73	123	49	33	77	68	49	81	80	100	41	138	95	102	56	108	79	122	102	113	98	110	88	81
Ohio	64	58	38	72	78	147	95	34	82	65	41	52	96	110	69	100	81	97	62	164	104	122	49	94	99	160	72	64
Indiana	54	68	53	64	85	134	38	33	90	68	41	55	64	116	38	94	87	100	50	97	84	174	71	97	96	163	56	112
Illinois	57	87	30	59	83	123	88	62	84	59	45	53	66	85	73	53	82	72	70	124	77	141	36	120	78	174	100	150
Missouri	59	78	24	56	80	114	38	44	88	30	62	42	70	43	50	50	73	37	100	110	98	143	30	105	82	151	135	108
Arkansas	94	21	20	68	92	105	37	22	133	33	105	124	79	33	66	81	90	58	126	222	62	121	55	70	88	84	63	65
Tennessee	86	32	54	62	89	100	36	44	81	55	93	93	91	70	45	239	96	86	109	110	79	127	166	119	97	77	86	59
Alabama	77	47	74	78	111	79	33	147	76	51	93	153	118	65	63	189	92	91	106	111	74	79	310	80	93	125	67	64
Mississippi	96	13	50	73	83	54	38	80	84	55	116	134	80	52	80	159	94	102	128	145	92	93	204	82	91	80	34	41
Louisiana	79	12	61	86	71	23	56	43	100	68	98	125	80	63	114	106	95	96	151	154	95	81	129	87	92	62	24	44
Texas	99	64	42	57	102	9	81	73	107	79	81	200	76	39	96	62	102	27	142	81	87	67	104	104	100	54	35	50
Oklahoma	95	97	32	60	98	21	181	33	101	42	55	50	96	53	61	53	59	29	171	124	73	174	26	40	95	90	94	80
Kansas	94	95	59	90	114	73	85	63	69	120	48	23	86	57	53	84	61	15	118	116	86	147	24	68	86	54	109	132
Nebraska	130	84	44	147	159	134	85	54	54	84	41	25	86	118	47	79	75	47	88	125	76	90	53	125	61	113	112	79
Iowa	78	129	39	59	84	164	130	79	74	60	16	47	72	82	60	38	83	40	60	97	97	82	47	76	61	180	98	159
S. Dakota	90	74	37	131	121	86	93	127	102	83	33	55	69	183	67	114	63	51	78	155	113	103	89	150	56	140	63	109
N. Dakota	81	69	42	67	77	109	38	104	125	97	23	48	46	174	166	78	92	89	69	156	106	112	123	122	79	120	77	70
Montana	84	57	65	93	--	--	--	--	--	--	--	--	114	112	67	42	104	112	67	150	95	154	47	100	65	107	74	84
Minnesota	88	95	71	33	81	88	49	154	148	64	20	40	74	142	95	67	93	93	103	131	133	120	80	113	87	106	80	149
Wisconsin	83	136	70	33	101	103	157	91	133	83	25	25	72	108	117	52	92	88	103	116	108	157	44	94	116	108	98	222
Michigan	84	106	46	27	90	155	97	75	133	90	46	18	83	81	140	91	92	100	94	97	122	155	40	90	95	78	117	129
Pennsylvania	80	102	50	34	81	171	50	40	130	64	53	43	139	86	89	162	77	115	64	101	100	149	100	62	117	137	78	91
New Jersey	68	114	87	71	97	153	42	24	113	63	37	55	148	44	129	196	80	146	79	178	92	114	118	26	129	114	57	88
New York	97	116	77	64	86	97	62	40	105	93	67	43	145	93	122	135	72	110	72	122	114	128	85	58	108	76	88	95

State	1930				1881			
	March to May	June	July	August	March to May	June	July	August
Maryland	64	85	36	24	79	182	54	26
Virginia	61	74	38	35	68	74	74	27
W. Virginia	64	64	41	55	89	131	90	30
Kentucky	51	45	30	61	73	123	49	33
Ohio	64	58	38	72	78	147	95	34
Indiana	54	68	53	64	85	134	38	33
Illinois	57	87	30	59	83	123	88	62
Missouri	59	78	24	56	80	114	38	44
Arkansas	94	21	20	68	92	105	37	22
Tennessee	86	32	54	62	89	100	36	44
Alabama	77	47	74	78	111	79	33	147
Mississippi	96	13	50	73	83	54	38	80
Louisiana	79	12	61	86	71	23	56	43
Texas	99	64	42	57	102	9	81	73
Oklahoma	95	97	32	60	98	21	181	33
Kansas	94	95	59	90	114	73	85	63
Nebraska	130	84	44	147	159	134	85	54
Iowa	78	129	39	59	84	164	130	79
S. Dakota	90	74	37	131	121	86	93	127
N. Dakota	81	89	42	67	77	109	38	104
Montana	84	57	65	93	--	--	--	--
Minnesota	88	95	71	33	81	88	49	154
Wisconsin	83	136	70	33	101	103	157	91
Michigan	84	106	46	27	90	155	97	75
Pennsylvania	80	102	50	34	81	171	50	40
New Jersey	68	114	87	71	97	153	42	24
New York	97	116	77	64	86	97	62	40

In 1881, very dry in the Southwest, and July and August central valleys and in the East.

In 1894, severely droughty conditions were confined to the central valleys and the Northwest.

In 1901, the central valleys, especially the western Corn Belt, suffered most.

In 1911, the greatest deficiencies in precipitation occurred rather early in the season.

In 1916, and 1924, the droughts covered comparatively small areas.

The drought seriously affected all growing crops, and the scarcity of water for livestock, and in some sections for domestic use, became a serious problem, especially in Kentucky and some other parts of the interior valleys. Winter wheat was not affected by the drought; in fact, the weather was favorable for ripening which gave a good quality of grain and better yields than expected in many places. Early spring wheat also largely escaped, but heat and drought damaged the late crop considerably, especially in the shriveling of grain. In general, oats were less harmed than spring wheat, though the late crop was badly damaged in the North Central States, notably in the upper Mississippi Valley, and late flax was materially reduced. Potatoes also suffered serious harm in the interior valleys. continued fairly good in many heavy producing sections. In orchards and gardens, pastures and hay, and corn were the hardest hit. Damage to these, together with the shortage of water for irrigation and other uses in many places, constituted the most serious aspects of the drought.

A prospective corn crop of 2,802,000,000 bushels on July 1 was reduced by September 1 to 1,983,000,000 or a loss of more than 800,000,000 bushels. The condition of pastures in many central and eastern parts of the country was, by far, the lowest of record.

In addition to its economic effects, mention may be made briefly that river stages show the extent and severity of the drought. In the Missouri Basin above Pierre, S. Dak., and in that part of the upper Mississippi Basin above the Iowa-Minnesota line low river stages are not unusual for July and August, but in the remainder of the drainage area of the Mississippi River system, and on the Atlantic slope of Pennsylvania, Maryland, Virginia, and North Carolina the dry weather is plainly reflected in the low water stages. Many of the small streams in the Missouri Basin are dry, and in the remainder of the drought area all streams are either as low as they have ever been in August, or are very close to the low record. In North Carolina and in the territory drained by the southern tributaries of the Ohio, low stages in 1925 appear to have been slightly lower than those prevailing in the present summer.

Wells are failing, water for stock is scarce where comparatively large streams are not available, and the matter of sewage disposal in a few places is becoming acute. The hydro-electric plants on the large streams are not suffering, but on the smaller streams they have either shut down or are drawing rather heavily on their reserves. Navigation on the controlled rivers is not interrupted, but on the Mississippi, especially north of Cairo, the low water has made it necessary to materially decrease the length of tows, which is a very serious interruption.

CAUSES OF DROUGHTS, HEAT WAVES, Etc.

Foremost in the minds of all during a summer like 1930 is the question, what causes such abnormal conditions? No conclusive and comprehensive answer can be given. Moreover, the answer will need to be varied and adapted more or less to particular cases. Directing our answer particularly to the extensive drought of 1930, all we can say is that these unusual conditions are best explained as a prolonged stagnation of the air over nearly the whole continental extent of the United States. In ordinary years this great blanket of atmosphere overlying the continent is in more or less active circulation. Cool air from the polar regions moves southward from time to time. This feature of circulation has been especially absent this summer. Warm air from the tropical latitudes moves northward at intervals. Air from the oceans and Gulf moves inland, and there is a more or less active and continuous interchange of these different air masses, causing the agreeable and favorable conditions that prevail in ordinary years. This circulation and interchange has been conspicuously absent for a long time during the present great drought.

During this stagnation the occasional showers and thunderstorms here and there over the drought-stricken region served only to dry out the overlying air masses. Only a part, at best, of this water is evaporated back into the free air, and with little or no moisture borne in by winds from the oceans, each successive inland shower, coupled with the stagnation and absence of general rain-causing processes, tends to further deplete the moisture supply and intensify the drought condition. It may be pointed out, also, that over most of the United States the summer heat is normally at its maximum about the last week of July. Therefore, summertime stagnation and lack of active circulation within the continental air blanket causes the absence of precipitation and permits the culmination of excessive temperatures, but the experts are unable to assign a specific cause for the prolonged stagnation.

CYCLES AND SEASONAL WEATHER FORECASTS

The occurrence of any notable weather event, such as the drought of the summer of 1930, is always made the occasion for discussion of the possibility of predicting such happenings sufficiently far in advance to permit of steps being taken, if indeed any such are possible, to lessen the economic loss which is bound to result to long as they arrive unheralded

Another even more futile imagination is that these untoward happenings can be caused or suppressed by man himself. For example, many letters are received urging that by the use of explosives and aerial bombardment, we can cause plentiful rain. Curiously enough, another group of writers urge us to employ aerial explosives and bombardment to destroy hurricanes, tornadoes, etc. Here we have the absurd representation that by the use of exactly the same means we can supply rainfall to drought-stricken regions, or we can suppress tornadoes, hurricanes, etc., which are frequently accompanied by even torrential rainfalls.

With reference to these and the possibility of future forecasting, the Weather Bureau continues to hold an entirely open mind and to seek for promising lines of attack on the problem of such forecasts, but we can not be led away from a sane and rational conservatism in these matters, either by the occurrence of great natural disasters or the confident assertions of advocates of this, that, or the other fanciful idea. In so far as a sound physical basis for seasonal forecasts is involved, the subject can be said to be still in the speculative stage. Some practical advances have been made by means of correlations, but the sum total of results attained by this method is relatively small.

The complexity of the problem is well illustrated by the weather extremes of the past year in different agricultural areas. While a great part of the United States was suffering for want of rain, western Europe was experiencing an extraordinarily wet harvest season, and in the great corn-growing region of Argentina the weather was so continuously wet as to delay the conditioning of corn for shipment overseas. It will be readily understood that until the different kinds of weather which occur simultaneously throughout the world have been satisfactorily correlated among themselves, forecasts therefor from a single factor, such as periodicity in sunspots or variations in solar radiation, can have no hope of success.

One line of attack on the problem of seasonal weather forecasts that is thought by meteorologists to offer some promise of success is that afforded by changes in the temperature of the surface waters of the oceans. It is well known that the oceans exert a pronounced influence on the climate of adjacent land areas. The character, amount, and extent of the influence depend on various circumstances, as latitude, direction of the prevailing winds, topography, and distance from the coast. Inadequacy of observations and other difficulties have hitherto operated to prevent any considerable investigations in this field by the Weather Bureau, although some preliminary work has been done in recent years. However, as a result of the development of commerce with Latin America and the opening of the Panama Canal observations from ships have been increasing from the strategic water areas embracing portions of the Atlantic equatorial currents and the Gulf Streams.

Much has been said by many people that weather recur in cycles. Naturally this whole subject is one, and we all recognize the ups and downs, and of heat and cold, wet and dry weather phenomena. These phenomena has failed to disclose any such recurrences as the word "cycle" connotes in the most people. Forecasts on any such basis as this will fail many times as they might succeed, and even at the best the intervals between recurrences are subject to such wide changes in length of interval, and the magnitude of the extremes, although sometimes large, are frequently entirely insignificant, so that the reality of cycles is very problematical, and forecasting by means of them is as yet unsuccessful.

The subject of correlations and periodicities of weather phenomena are under continuous investigation by one or more of the experts of the Bureau, in the hope of discovering useful information.

WEATHER SERVICE FOR AIRWAYS

In previous annual reports, particularly those issued in 1927, 1928, and 1929, the bureau's service for flying activities was discussed at some length, principally from the point of view of organization and the legislation authorizing it. It seems proper at this time to indicate the general character of this service, as now organized, and to point out needs for expansion as the network of airways is still further extended.

The Weather Bureau is charged with the duty of all interests - agriculture, commerce and navigation includes the air as well as the sea. In doing this the bureau has organized a network of some 210 first-order stations, well distributed over the entire country. These stations regularly exchange reports twice daily and also keep continuous records of weather conditions for statistical and research purposes. The twice-daily reports are used in issuing summarized statements and forecasts which are given wide dissemination by telegraph, telephone, radio, and the press. This may be called the bureau's general or primary service.

In addition, several more detailed and intensive services have been organized to meet special needs, including the protection of fruit and other crops from frost, warnings of conditions favorable for floods, forest fires, hurricanes, and other violent storms. For these services numerous second-order stations - several hundred of them - have been established at points from which experience shows that the information is needed. The reports are made by noncommissioned personnel, in accordance with prearranged schedules or on call.

The most recently organized of these intensive services is that for flying activities on commercial airways. The bureau's authority for this service is defined in section 5 (e) of the air commerce act of 1926. In organizing the service, close cooperation is maintained with the Department of Commerce which is charged with providing communication, lighting, and landing facilities for the airways. As a rule, detailed



Chart showing commercial airways for which intensive weather service has been organized. Open circles are Weather Bureau airport stations, with continuous 24-hour service. Dots are additional stations off the airways that furnish three-hourly reports to designated centers.

surveys of proposed airways are made jointly by representatives of both departments. In the course of these surveys a study is made of past records in order to determine the general character of the weather conditions that are likely to be encountered. Pilots and officials of the air-transport companies and others who are familiar with the section are consulted with a view to determining what the needs are and how to meet them. Finally, a program of service is formulated and organized. Naturally, it is necessary to keep this program within the limit of funds appropriated for the purpose and also to distribute those funds equitably and impartially to all sections of the airways system.

The basic features of the service are timely reports of current conditions and short period forecasts. In other words, the aim is to give the pilot the weather of the "now" and the "soon-to-be". To do this, special observing stations are established along and near the airways. The distance between these stations varies from 5 or 10 to 100 miles, depending on the topographic and meteorological characteristics of the section. The time interval between reports also varies, this depending largely on the volume of traffic. Where flying is more or less continuous, both day and night, reports are received from all observing stations on the airways once each hour, and in some cases intermediate half-hourly reports are received from the more important terminal stations. On airways having as yet but little traffic - one regular daily flight each way, for example - the reports are timed to fit the schedules. This latter type of service as a rule characterizes only the earlier stages of an airway's history. As flying increases and off-schedule flights become common, experience shows that the needs for service can be met adequately only by frequent and regular reports.

Attention is invited to the accompanying chart which shows the airways for which service is now furnished. At about 50 of the more important terminal airports on these airways the bureau has established continuous 24-hour service with full instrumental equipment and personnel of four to seven technically trained men. At some 250 intermediate stations the observations are made by properly instructed, though not technically trained, personnel who report the conditions as observed by eye or with comparatively simple instrumental equipment. Reports from these special stations are transmitted to the bureau's more important centers on the airways.

Naturally the prompt collection of these reports (and unless they are prompt, all the effort is wasted) requires a highly efficient communication system, whose organization is a function of the airways division of the Department of Commerce. It was early found that, for this particular purpose, dependence can not be placed on the ordinary commercial facilities. During the time of peak loads, that is in the middle of the day, absolute promptness could not be guaranteed. All types of business are entitled to equal service. It was evident, therefore, that a system of communications under absolute control is necessary. This has been

accomplished on some of the main airways through the installation of a printing telegraph, or teletype, circuit. The circuits consist of leased telephone lines 500 to 800 miles in length between terminal airports with drops at the intermediate weather-reporting stations, each one of which has an automatic typewriter, or teletype machine. The messages are typed on these machines in sequence, the various stations following one another in rapid succession; and each message is received on tape by all other stations in the circuit. This system of communications is prompt and is rapidly increasing in efficiency and reliability. The Department of Commerce plans to extend it eventually to all interstate-trade air routes.

All reports, whether sent by teletype, telephone, telegraph, or radio, include information concerning the following elements: General condition of sky and weather; ceiling; visibility; surface wind direction and velocity; temperature; barometric pressure; and miscellaneous conditions, such as thunderstorms, squalls, and state of landing field as affected by rain, snow, etc.

In many cases dew point is also reported, and some of the airport stations (about 45 at present) give detailed data of wind direction and velocity at various heights.

For the general condition of sky and weather no instruments are required, but certain definite terms have become standard for expression, such as "clear", "broken clouds", "overcast", "fog", "heavy rain", "sleet", etc. This first word in the report tells the pilot at once whether conditions are satisfactory, impossible, or simply uncertain and therefore subject to further study.

The next two items, ceiling and visibility, usually answer this question of uncertainty. For observations of ceiling at night when clouds are present the so-called "ceiling light" is in general use. A beam of light is shot upward, in some cases vertically, in others at a 45° angle, and in still others at some intermediate angle. The use of this instrument has not as yet wholly passed the experimental stage, but the consensus of opinion is that a vertically projected beam gives the best results. There is still some uncertainty also as to the most satisfactory intensity. At present 250-watt bulbs are in general use, although a higher intensity is favored by some, especially for stations in mountainous country, where high ceilings are essential for safety. In all cases the beam makes a spot of light where it strikes a cloud. This spot is more or less definite and well marked, depending on the density of the cloud mass. The height of the spot, and therefore of the ceiling, is determined by means of an alidade, or clinometer. The angular reading of this instrument, together with the known distance of the light source from the point of observation, provides the necessary data. In many cases the alidade is graduated in heights instead of degrees and thus eliminates the need of computation or the use of tables or graphs.

For observations of ceiling in the daytime, so-called "ceiling balloons" are used. These are about the size of ordinary toy balloons, although of a somewhat better quality. They are filled with hydrogen until just capable of sustaining a 40-gram weight. When released, they rise at a known and fairly constant rate. It is then only necessary to note accurately the exact time of their disappearance in the cloud. As in the case of ceiling lights, when the cloud mass is of a light and tenuous nature, there is some slight uncertainty as to the exact moment of disappearance, and it is general practice to report the height at which the balloon begins to be indistinct. Ceilings are usually given only to the nearest hundred feet. Greater precision is not warranted in view of the fact that the cloud base itself varies as much or more within relatively short distances.

Observations of visibility are noninstrumental. It is customary to give the greatest distance at which conspicuous objects can be clearly seen. Whenever practicable, lights are used at night. This method is approximate only, but fortunately it is most nearly accurate at times when the information is of most importance, that is, when visibility is low. It should be stated that observations of visibility show conditions in the horizontal, not in the vertical. No attempt is made to measure vertical visibility except when clouds are low, in which case it is defined by the height of the ceiling.

These two elements - ceiling and visibility - have been dwelt on at some length for the reason that all pilots ask first for information regarding them. Many ask for nothing else if these are favorable. Whereas they were never thought of in meteorology before the days of ~~the war~~, now they are among the most important working elements of the meteorologist whose duty it is to tell pilots what the weather is or is going to be.

Wind direction and velocity at the surface, temperature, dew point, and barometric pressure are all so well known, as also the instruments used in observing them, that only a passing reference is necessary. Information concerning surface wind is useful principally in connection with taking off and landing. Temperature and dew point together determine the likelihood of fog and of ice formation on the planes. Reports of pressure enable the pilots to correct their altimeters, in addition to furnishing the meteorologist with basic data for synoptic charts or weather maps.

Miscellaneous phenomena are observed directly without instruments. They include thunderstorms, line squalls, exceptionally heavy rain or snow, ice formation as reported by incoming pilots, and any other conditions a knowledge of which is useful and at times vital in determining whether or not flights should be made. Special attention is always given to this part of the reports.

For measurements of upper wind direction and velocity, so-called "pilot balloons" are in general use at airports. These balloons are about 6 inches in diameter and are made of pure rubber. Different

colors are employed to give the best possible visipility against varying backgrounds of sky and cloud. The balloons, when filled with hydrogen, are about 28 to 30 inches in diameter and ascend at a nearly uniform rate of 600 feet a minute. Their ascent is watched with a theodolite, and angular readings are made each minute. By means of slide rule, portable telephone, and plotting board, computations are made while the observation is in progress, with the result that the wind conditions at various levels are known in detail within two or three minutes after the balloon disappears. For observations at night a small lantern is suspended a few feet below the balloon. Reports containing these data are received as a rule at the Weather Bureau's airport stations, where they are made available in various ways. In almost all cases the reports are posted on a bulletin board. If conditions are generally good, the pilots are usually satisfied with a reading of the bulletin; but, if conditions are uncertain in spots, individual copies are sometimes made for the pilots to take along on their flights.

Along with this organization by the Weather Bureau, the Department of Commerce has established a network of radio stations which broadcast the reports for certain airways once each hour. There are now about 40 such broadcasting stations. Some of the air transport companies have equipped their planes with receiving sets and others are doing so as rapidly as practicable. Thus, in addition to the information given at the airport stations of the bureau, the pilots receive supplementary reports while making their flights.

include not only reports of current conditions
and changes for the next few hours. Short-range

ly proved to be a great aid, and it seems certain that, with the increased accuracy that is bound to come, they will ultimately constitute the most valuable feature of the weather service. There is some question as to most suitable period of time to include in the forecasts. Naturally the shorter the period, the more precise the forecasts; but, on the other hand, their value is limited unless they cover at least a reasonable period. As a basis for compromise, the maximum length of the great majority of flights has been chosen, that is three to four hours.

As earlier stated, the basic material for all forecasting is the country-wide, twice-daily collection of reports which are used in constructing the well-known weather maps. The forecasts for 12 to 24 hours, based on these reports, are quite dependable but are necessarily given in general terms. What is needed is their amplification and localization. For this purpose supplementary reports from relatively small areas are required, small at any rate as compared with the country-wide, twice-daily system.

As an experiment the period of three hours has been selected, the observations being made at 2, 5, 8, and 11 a.m. and p.m., 75th meridian time. About 110 stations are at present in this system. They transmit their reports to airways-forecast centers at Atlanta, Ga.; Cleveland, Ohio, Dallas, Tex., Fort Crook (near Omaha) Nebr., Oakland, Calif.,

Portland, Oreg., and Salt Lake City, Utah. The data are entered in detail on base maps, and lines of equal pressure are drawn. The maps for 8 a.m. and p.m., seventy-fifth meridian time, being based on the bureau's primary system of reports, are of course much more complete than are the six others. The latter are used as auxiliary to the former and serve to show the changes taking place in the areas for which the short-range forecasts are issued.

Although designed primarily for flying activities over established airways, the 3 hour system of reports and forecasts in large part also solves the problem of so-called "off-airways" flights. Before the organization of this system there was no provision for obtaining special reports from places not on regular routes, except by special call and at the expense of the pilots desiring them. Now, however, information is fairly complete for large areas, and any one desiring reports for cross-country flights in these areas has only to listen in at the proper times, since these summaries are regularly broadcast, as well as the hourly reports of conditions along the established airways themselves.

Thus far the need and value of short-range forecasts have been stressed. They are relatively precise and cover approximately the duration of nearly all flights. But they will never do away with the necessity of the longer-period forecasts, to which rather are they supplementary. The 12 to 24 hour forecasts will become increasingly important. While the individual pilot is interested in the weather for a few hours, the operations manager of an air-transport line ~~needs to make his plans as far in advance as possible. Furthermore,~~ is this true if passenger service is included.

Thus, the three main features of weather service for aeronautics are each essential to the proper functioning of the others. (1), The frequent, individual reports tell of the weather now; (2), The short-range forecasts cover the individual flights or announce the weather that is soon to be; and (3) the basis general forecasts indicate the likelihood of successful flying to-morrow. Considered in reverse order, the general forecasts form the groundwork of the entire service; they are supplemented by the more intensive shorter-period forecasts; and both of these are still further supplemented by timely reports of current conditions, which check the forecasts previously made and provide data for slight modification in them, if necessary.

Again referring to the chart, the system of airways there shown is only a beginning. Already surveys are being made by the Department of Commerce for many additional lines, and eventually the entire country will be covered. As rapidly as these airways are established the Weather Bureau, to the extent that additional appropriations permit, will organize service for them, along the lines of the present service, with such modifications in details as experience may show to be desirable. Fortunately the cost of these extensions will be considerably less per airway mile than that of the service thus far organized, since much of the latter will give information that will meet in part the needs of the new lines.

x 171

